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Hinders and solutions in regard to the environmental impact from construction transports

A study of Serneke's ambitions to reduce construction materials transport emissions

Master's thesis in Design and Construction Project Management

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Abstract

The greenhouse gas emissions from the domestic construction industry have been approximated to 11,7 million tons of CO_2-equivalents, where 10% originates from construction transports. The Swedish National Board of Housing, Building and Planning has been assigned by the Swedish parliament to initiate a compulsory climate declaration. From the 1st of January 2022, a climate declaration is a requirement for the construction of a new building. It has been identified that the construction industry struggles with assessing the environmental impact from transports. The thesis aims to investigate the possibilities to reduce the environmental impact from construction transports in relation to the production phase as part of the Swedish contractor Serneke's ambition to strengthen their competitiveness by sustainability improvements. A qualitative case study of hinders, solutions and effects for Serneke in regard to transport organization and abilities to reduce transport environmental impact is carried out, based on interviews with *Purchasers, Environmental specialists* and *Site Managers*. One important aspect is to address projects that differ in project size, time and cost, and contextual factors that affect construction transports.

The study reveals that the main hinders which makes it difficult for Serneke to address the environmental impact from construction transport are: *The cost focus, Transports included in the material purchase, Inefficient deliveries, The ambiguity of responsibility*, and *Project independence.* The following causes of action are identified as solutions:*Request transport specification, Make use of a construction consolidation center, Apply long term agreements,* and *Implement closer collaborations*. First, the study concludes that Serneke should request that the information regarding the transport is not bundled together with the material. Second, utilizing a construction consolidation center is beneficial, especially when aiming to improve Serneke's environmental performance. Third, it is identified that long term agreements and close collaborations are paramount when striving for a reduced environmental impact. The study also shows that there is a lack of knowledge regarding the compulsory climate declaration. All together, such achievements will contribute to Serneke's ambitions to strengthen its competitiveness by improved sustainability.

Keywords: Environmental impact, Sustainability, Climate declaration, Construction transports, Construction logistics, Serneke

Hinder och lösningar i relation till miljöpåverkan från byggtransporter

En studie om Sernekes ambitioner till att att minska utsläpp från byggmaterialtransporter

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Sammanfattning

Utsläppen av växthusgaser från den Svenska byggindustrin har blivit uppskattade till 11,7 miljoner ton CO_2-ekvivalenter, där 10% härstammar från byggtransporter. Boverket har fått i uppdrag av riksdagen att ta fram en obligatorisk klimatdeklaration. Från och med den 1 Januari 2022, ska en klimatdeklaration upprättas vid nybyggnation. Det har identifierats att byggbranschen har svårigheter med att bedöma miljöpåverkan från transporter. Denna studie fokuserar på att undersöka möjligheterna till att reducera miljöpåverkan från byggtransporter i relation till produktionsfasen som en del av den svenska entreprenören Sernekes ambition till att stärka deras konkurrenskraft genom hållbara förbättringar. En kvalitativ studie av hinder, lösningar och effekter för Serneke med hänsyn till organiseringen av transporter och möjligheter till att minska miljöpåverkan har genomförts baserat på intervjuer med:*Inköpare, Miljöspecialister* och *Platschefer*. En viktig aspekt är att adressera projekt som skiljer i storlek, tid och kostnad, och relatera detta till byggtransporter.

Studien identifierar att de huvudsakliga hindren som gör det svårt för Serneke att adressera miljöpåverkan från transporter är:*Kostnadsfokus, Transporter inkluderade i materialköp, Innefektiva leverans, Tvetydighet av ansvar* och*Projektfrihet*. Följande angreppssätt har identifierats som lösningar:*Efterfråga en specificering av transporter, Nyttja användandet av konsolideringscenter, Tillämpa långtgående avtal* och *Implementera närmare samarbeten*. För det första, konkluderar studien att Serneke ska efterfråga att informationen gällande transporter inte är sammansatt med material inköpet. För det andra, utnyttjandet av ett konsolideringscenter är fördelaktigt speciellt när Serneke strävar efter att förbättra sitt hållbarhetsarbete. För det tredje, har det identifierats att långtgående avtal och nära samarbeten är avgörande för att uppnå en minskad miljöpåverkan. Studien visar också att det krävs ytterligare kunskap gällande upprättandet av den obligatoriska klimatdeklarationen. Slutligen, genom att uppnå detta kommer Sernekes ambitioner och konkurrenskraft gällande hållbarhet att stärkas.

Nyckelord: Miljöpåverkan, Hållbarhet, Klimatdeklaration, Byggtransporter, Bygglogistik, Serneke

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Lastly, we would like to thank everyone that took their time sharing their thoughts and knowledge and participated in an interview. This information forms the basis for the findings in the thesis and is therefore of utmost importance for our research. We gratefully acknowledge the feedback provided by our opponents, Nikolina Bolvede and Erik Andreasson. Their input has served the thesis from an additional point of view and it has provided us with thoughtful reflections and possible improvements.

Gothenburg, May 2022

Simon Kvarnsund & Victor Pantzar

List of Acronyms

Below is the list of acronyms that have been used throughout this thesis:

CCC	Construction Consolidation Center
CC	Consolidation Center
CLC	Construction Logistics Center
JIT	Just in time
SCM	Supply Chain Management
TPL	Third Party Logistics

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1 Introduction

This section is initiated by presenting the background of the issue under investigation and outlining the current situation and potential issues. The aim of the research is formulated and research questions are presented. This is followed by an illustration of the structure of the thesis as well as a section presenting the limitations that set the boundaries for the study.

1.1 Background

The construction industry is very material and resource intensive and therefore represents a considerable portion of the Swedish energy usage. In 2019, the greenhouse gas emissions from the domestic construction industry were approximately 11,7 million tons of CO_2-equivalents (Boverket, 2021a). This corresponds to just over 21% of Sweden's total greenhouse gas emissions. As Sezer and Fredriksson (2021a) describe, approximately 10% of all CO_2 emissions from construction originates from transports. Extensive use of material generates large amounts of transports, both in terms of materials that need to be extracted from the construction site or transported to the construction site in relation to the production flow. In addition, transports within the Swedish construction industry are estimated to correspond to approximately one-third of all urban goods transports (Sezer & Fredriksson, 2021a).

The transport of materials to the site represents the connection between supply logistics and on site logistics (Dubois et al., 2019). According to Guerlain et al. (2019), different types of vehicles are often used depending on the material, although large lorries are identified as the most common transportation method. Furthermore, Dubois et al. (2019) argue that the nature of the construction industry, where material is often ordered when needed and without coordination among actors on site, results in unnecessary transports. This affects both the project and the surrounding area, the high amount of deliveries causes congestion within cities since deliveries disturb and hinders other traffic (Sullivan et al., 2010). In addition to traffic congestion, construction transports can have an impact on those living in the surrounding area in terms of aspects ranging from direct noise and safety disturbances to long term health effects (Dubois et al., 2019). Moreover, Sezer and Fredriksson (2021a) describe that the Swedish industry struggles with a lack of transport coordination to construction sites. This poor coordination results in a situation where vehicles carry a low fill rate and/or use of inappropriate vehicles (Sezer & Fredriksson, 2021a). On

the other hand, materials can be purchased in bulk in order to receive a discount. While it may reduce the number of transports driven to the site, it creates issues at the site instead, since material needs to be stored which is often not possible in a sufficient way (Dubois et al., 2019).

However, it is known that transports within the construction industry face numerous challenges, not the least to reduce the environmental impact, still, there is a lack of knowledge regarding the relation between transports to construction sites and actual levels of emissions (Sezer & Fredriksson, 2020). In the same way, the relation between various ways of coordinating transports, its efficiency and environmental impact is not properly developed (Dubois et al., 2019).

The Swedish parliament has decided that all new buildings should be assessed and accompanied by a climate declaration (Boverket, 2021b). As of the 1st of January 2022, this new act of climate declaration is implemented within the construction industry, which requires that almost all new buildings under construction need to declare their climate impact. This new act includes all stages within the construction phase, from raw material extraction to production on site (Boverket, 2021b). The stages are divided into five different areas, where stage A1-A3 focuses on the production and handling of construction material, and the following stage, A4 concerns the transport of material from the supplier to the construction site. Furthermore, the assembly on site is assessed within the last stage, A5 (Boverket, 2021c).

These new requirements pose several challenges for the construction industry, and actors within the industry need to adapt their operations according to the new legislation. They are forced to prioritize and focus on developing a system for assessing the different areas included in the climate declaration. To measure the climate impact from transports within the construction industry, area A4, is difficult in practice. The Swedish National Board of Housing, Building and Planning has developed a tool to assist this transition, where generic data can be found. Still, if assessed and evaluated, companies could benefit from performing calculations based on information specific for the project, instead of using the generic data (Boverket, 2021d). With deeper knowledge regarding the actual impact from transports it is, for example, favorable to use suppliers in close geographical proximity, hence achieving a lower score. In the same way, companies can set requirements when they procure their logistics services, for example demanding certain types of vehicles or fuels (Boverket, 2021d).

It is in the interest of the whole construction industry to investigate potential solutions to handle logistics since transports within the Swedish construction industry are struggling with inefficiency and large emissions of greenhouse gases. Due to the fact that new requirements force actors to declare their climate impact, there is a need for new tools and techniques within the industry.

The thesis is performed in collaboration with the Swedish construction company Serneke. From Serneke's perspective, the main reason why they want this research to be carried out is that they do not have any particular practice or structure in

place for handling and measuring the impact of transports. Considering the new requirements regarding climate declaration, Serneke has identified a strong need to develop their competence within the area to stay competitive. Also, in line with their business strategy, where Serneke is focusing on becoming more environmentally friendly in their projects, they are aiming for a better understanding of construction transports. This increased competence could likewise assist them in setting relevant requirements when they are procuring transport services.

1.2 Aim

The overall aim of the study is to investigate Serneke's current situation regarding construction transports and possible ways to reduce the environmental impact within the construction phase, as a part of their ambition to strengthen their competitiveness regarding sustainability. Tools to assist the transition towards a reduced environmental impact from construction transports will be assessed, for example, how to evaluate and optimize transports of materials to the construction site. This research will be performed in close collaboration with Serneke and the main data concerning the current situation and future possibilities will be based on their experiences.

The objective is to propose suitable solutions to use when planning and managing transports to various construction projects. Furthermore, the idea of reducing the environmental footprint is in line with Serneke's strategic vision as well as the general goal of improved sustainability in the construction industry. Taking the new requirement of climate declaration into account and subsequently planning and structuring construction transports will provide strategic advantages when performing construction activities.

The expected outcome is for Serneke to be able to use the proposed solutions as a basis for planning and executing construction transports in order to reduce the environmental impact and facilitate the development of climate declarations. This thesis contributes to the industry by increasing the understanding of construction transports and their environmental impact. Also, the study discusses and assesses possible ways forward to support the transition towards a sustainable construction industry.

1.3 Research questions and thesis structure

Based on the aim of the research, the thesis strives to answer the following research questions:

- *What are the main hinders that makes it difficult for Serneke to address the environmental impact from construction transports?*
- *What possible solutions can be identified for Serneke to improve transport performance and its environmental impact and what are the effects of the solu-*

tions?

- *How does an increased focus on construction transports contribute to Serneke's ambition to strengthen its competitiveness in regard to sustainability?*

The structure of the thesis is illustrated in Figure 1 below. With the aim as a point of departure, theoretical findings and empirical data were collected and analyzed. The three research questions were answered by an analysis based on an interplay of theory and empirical data. Furthermore, a discussion covers the findings of the study and conclusions were then formulated.

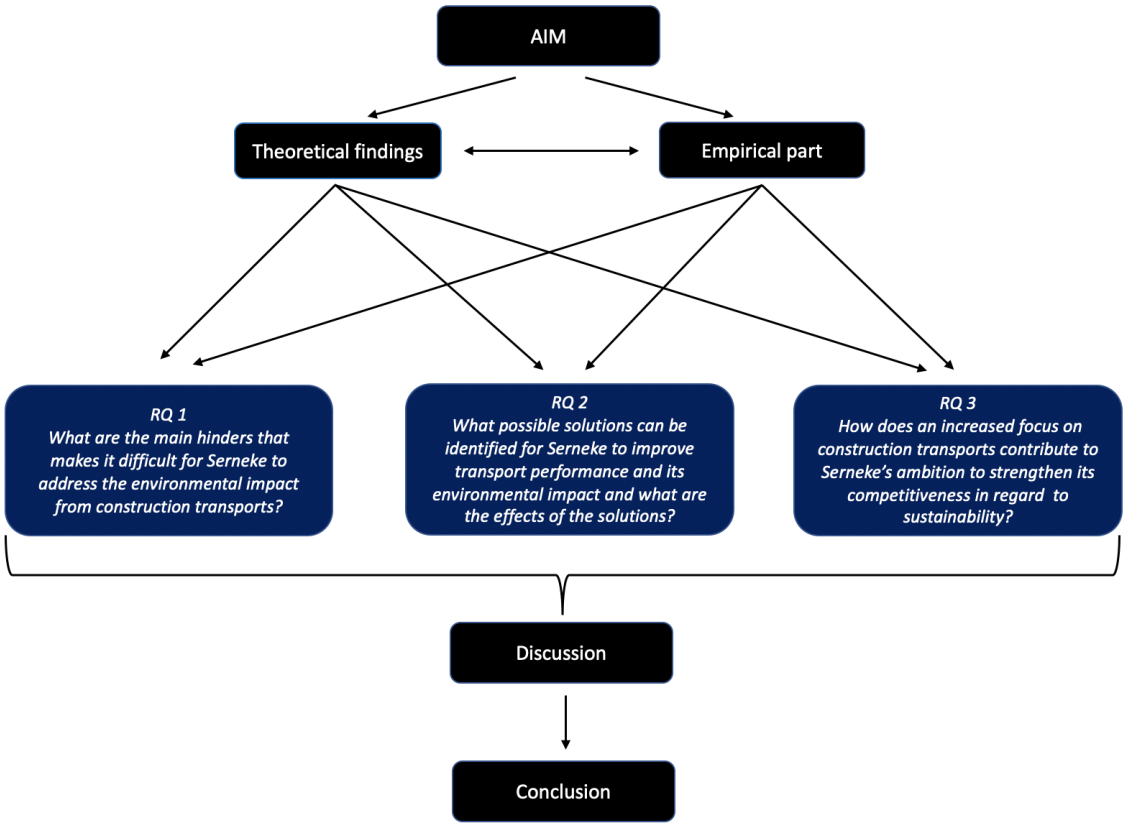

Figure 1: The structure of the thesis

1.4 Delimitations

Transports within the construction industry can include a wide spectra of different activities, ranging from transports of materials to equipment and transports related to the employees. In order to have a clear aim and scope, this research will be delimited to the types of transports categorized in A4. Accordingly, the focus is on transports of construction material from place of manufacturing to the place of assembly (the construction site). More specifically, materials used for the building's structural system as well as materials for interior walls and the climate shell will be taken into account. Consequently, the study does not go into depth regarding

transports of, for example, equipment, personnel, or consumable materials.

Furthermore, the study will be delimited to the Swedish construction industry and therefore based on Swedish laws and requirements. Also, since the research is performed in collaboration with Serneke, the collected data mirrors their working practices. Hence, the outcome and conclusions of the study are adapted to Serneke's business context and intended to assist Serneke in future work concerning construction transports and their environmental impact.

2 | Theory

In this chapter, a theoretical framework will be presented as a basis for further discussions as well as providing the thesis with adequate theory regarding the discussed subjects. This chapter starts with section 2.1 presenting the typical behavior of the Swedish construction industry, with emphasis on supply chain management in construction and its impact on logistics. This is followed by section 2.2, which describes and defines logistics and transports and its importance within the industry. Moreover, some logistics solutions with the potential of reducing the environmental impact are acknowledged in 2.3, followed by 2.4 describing the role and importance of the procurement process. In part 2.5, the Swedish climate goals are presented and 2.6 outlines the new act for climate declarations of buildings, including how it should be implemented and its purpose. Finally, the environmental impact of transports is exemplified in 2.7 and concludes the theoretical chapter.

2.1 Supply chain management in construction

It is often claimed that the Swedish construction industry suffers from low performance and productivity (Sezer & Fredriksson, 2021a). This is explained to originate from different reasons, where one is that the construction industry in Sweden is very project based. There is always a large variety of what is constructed and this makes the construction industry highly complex (Dubois et al., 2019). The construction industry is dependent on various actors and stakeholders, which makes it a difficult task to coordinate and collaborate between them. The project nature of the industry together with strong fragmentation and a lack of coordination between different stages in planning and execution of construction, contribute to a lack of efficiency (Dubois et al., 2019). In addition, insufficient information sharing, lack of knowledge, and short term relationships aggravate the poor performance.

The collaboration between the client and the one performing the project is often done in one of two ways in Sweden (Boverket, 2021e). Either, a main contractor has the overall responsibility as a general contractor, or the client themselves procures multiple contractors in a divided contract. This often results in a situation where a multitude of people is working on the same site but employed by different companies. A large construction project can include a multitude of companies and thus increases the difficulty of organizing different people in order to achieve a joint effort (Balasubramanian & Shukla, 2017).

The construction supply chain is extensive and composed of various actors with different levels of integration between them, as illustrated in Figure 2. Often, many actors within the construction industry are used to their way of working and therefore specialized within their area of expertise. As a consequence, little time is spent on coordinating supply chains with others involved in the project (Dubois et al., 2019). Different actors tend to prioritize what's best suited for them and there is often no collaborative approach in place (Dubois et al., 2019).

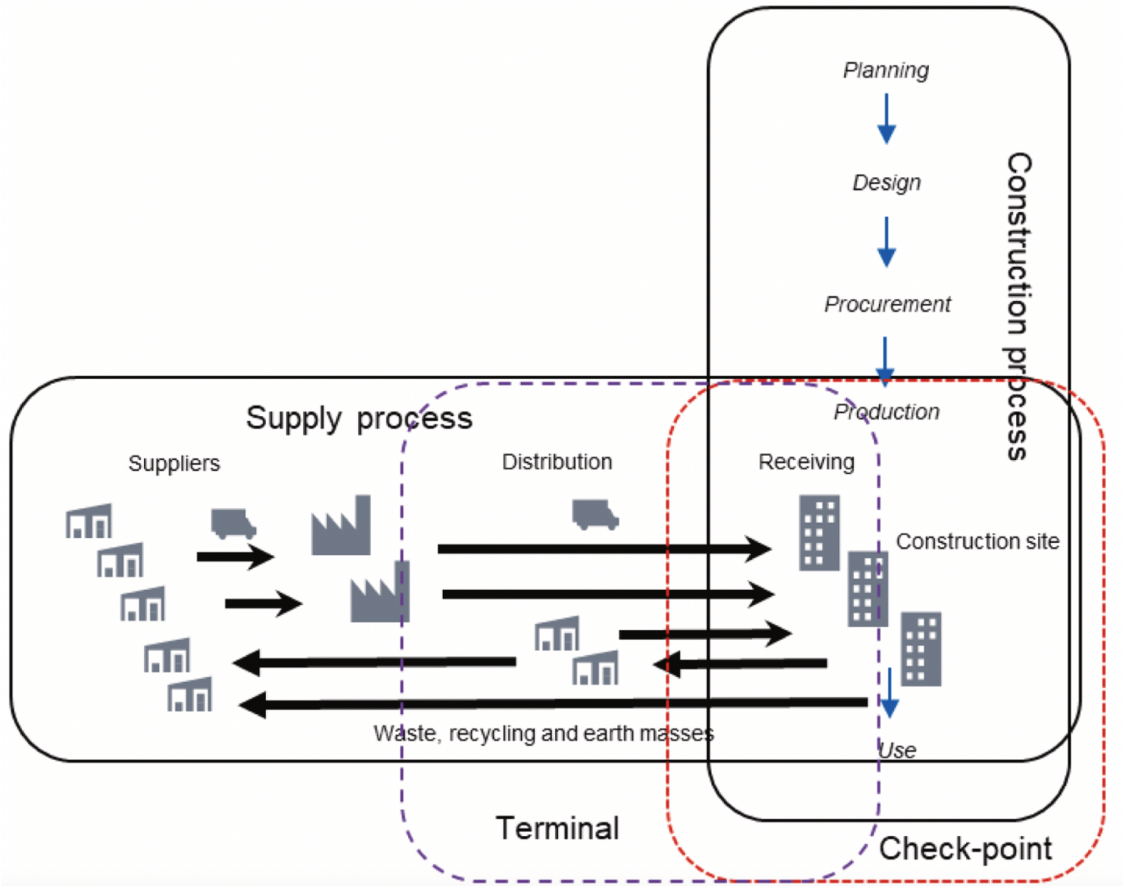

Figure 2: An illustration of the construction supply chain (Sezer & Fredriksson, 2021a)

By reviewing Figure 2, a large number of actors and processes with a meaningful contribution to the supply chain can be identified. Different decisions taken in the supply process will impact the construction process and vice versa. When applying the understanding of logistics, it can also be understood that all these different actors both can and will, affect the process of delivering supplies.

Since the construction industry is project based and characterized by temporary endeavors the supply chain is remarkably different from other industries. Vrijehof and Koskela (2000) define that the construction supply chain revolves around the project site where all material is destined, but also that it is temporary and involves a huge level of fragmentation between different stages and actors (Vrijehof &

Koskela, 2000). Furthermore, Vrijehof and Koskela (2000) argue that supply chain management (SCM) in construction can have many forms and affect the supply chain in different ways. Traditionally, logistics in a construction context has been concentrated on activities taking place on site. However, instead of solely focusing on the on site processes, Vrijehof and Koskela (2000) illuminate the logistics related to delivering material from the supplier to the construction site, as a major part of SCM. Moreover, Behera et al. (2015) mention that very few companies have predefined ways of managing their supply chain since it is so strongly dependent on the project's characteristics and consequently poses many insecurities. The typical supply chain in a construction project can include upwards of 1000 different actors that deliver different materials or services, hence managing the whole supply chain poses a big challenge (Balasubramanian & Shukla, 2017).

The goal of implementing SCM is to increase profits and at the same time improve what is delivered to the customer (Tennant & Ferine 2014). Tennant and Ferine (2014) also describe that when discussing SCM, different ways of collaboration are often brought up as a good way of implementing SCM. Managing the construction supply chain can improve a project's environmental performance. By working strategically with the involved actors and suppliers, collaborative measures can be put in place in order to reduce the environmental impact. Also, having a long term collaborative setting enables a higher level of strategic work aimed at reducing the climate impact (Badi & Murtagh, 2019).

This could result in strategic alliances that, for example, could focus on co-loading material and hence reduce the number of deliveries that have to access the site, improving both site operation and lowering climate impact (O'Brien et al., 2008). Also, SCM enables the use of smaller work packages by collaborating with the supplier and set requirements for deliveries, enabling for instance just in time deliveries. Consequently, the ability to use a specialized logistics contractor, a third party logistics provider (TPL) and consolidation centers for managing and handling material is enabled by a managed supply chain (O'Brien et al., 2008). In addition, the role of the client, contractor, supplier, and municipalities play a large role in SCM and are connected and linked together through different contracts established in the process of procurement as illustrated in Figure 3.

Through the supply chain, different actors have to interact in order to exchange information and orders of what should be delivered, as illustrated in Figure 3. The process begins with the client/developer who sets the framework for what should be produced. Then, depending on the chosen type of collaboration, different actors are included in the process.

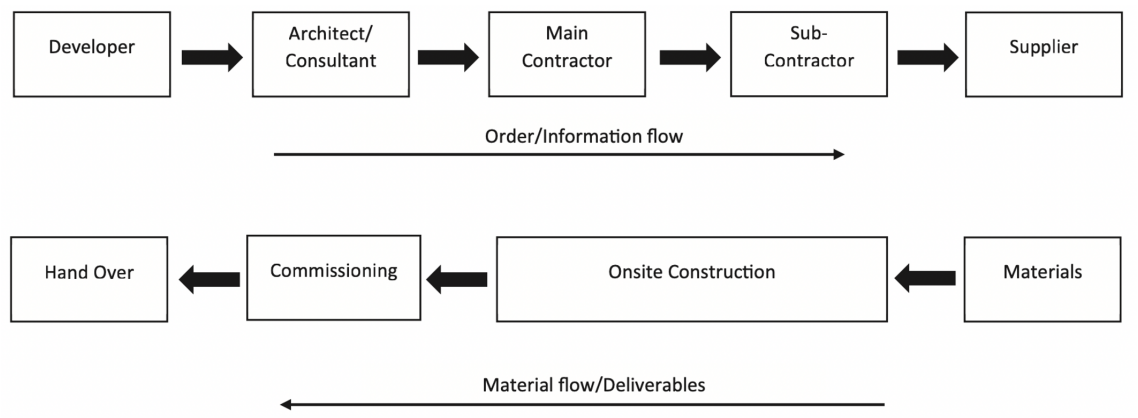

Figure 3: A typical construction supply chain (Balasubramanian & Shukla, 2017)

Client
As mentioned above, the client is the one who sets the requirements for what should be produced and consequently have a large opportunity to impact the process. In the same way, the client can introduce a high level of "green" thinking into the supply chain (Balasubramanian & Shukla, 2017), and thereby for example set a frame for a focus on environmental transports throughout the whole chain.

Contractor
The contractor is the one who is performing the construction, either in house using their own personnel, or by contracting other specialized companies. Depending on what type of contract that is in place, there is a varying level of responsibility and possibility for the contractor to make decisions regarding the process (Boverket, 2021e). Following this, the contractor can have the possibility to impact the use of environmentally friendly alternatives. Even if the client has not set specific demands, the contractor could apply a more ambitious approach towards, for example, sustainable transports.

Supplier of material/ Transport services
Suppliers in the construction industry also plays a significant role. Since the industry is very material intensive and strongly dependent on a functional flow of material to the site, the integration of suppliers in the management of the supply chain can have a large impact. Often, the suppliers deliver material directly to the site, i.e they have their own curriers, and material is often purchased "delivered" (Ying et al., 2018). Consequently, in order to affect the transports, the suppliers of material need to be included in the process.

Municipality/ City
In Sweden, the three largest cities, Stockholm, Gothenburg, and Malmö have set additional demands regarding the environmental impact in projects when they are the client. These demands can include regulations regarding what type of vehicles are used and their maximum level of emissions (Trafikverket, 2021b). In addition, these cities have also taken part in the initiative of transports, initiated by Fossil free Sweden. In accordance with this, all domestic transports used within these cities

should be fossil free by 2030 at the latest (Fossilfritt Sverige, n.d.)

2.2 Transports and logistics

The construction industry revolves around producing different structures and is therefore dependent on a supply of different materials. As Sullivan et al. (2010) describe, managing the constant supply of material is a process that requires a lot of resources during the whole construction time. Material can represent upwards of half of a project's total cost, indicating the large scope of material purchases and supply (Ying et al., 2018). Hence, the activity of transporting these materials to the site of assembly can have a large impact on the overall success of the project. To achieve a continuous flow of material to the site, different logistics activities need to be initiated before the material is actually transported to the site. Dubois et al. (2019) mention that logistics management is a process that can stretch beyond the construction site and include important activities such as planning for the correct type of load carrier or adequate and correct labeling. Logistics is also a major activity after material has reached the site, material often needs to be moved around and brought to the right place when ready for assembly (Sullivan et al., 2010)

As Sullivan et al. (2010) argue, the process of managing logistics is a difficult undertaking, not least since a construction project involves many different actors and subcontractors. As a consequence, the typical construction worker in Sweden spends upwards of half their time moving things around and handling deliveries destined for the construction site (Sezer & Fredriksson, 2021). This "waste of time" originates from the uncoordinated nature of deliveries to construction sites. Often, spot purchases cause deliveries of small items or single pallets which consequently causes deliveries to access the site often and be driven with a low fill rate (Dubois et al., 2019). Moreover, it is evident that this poses a huge challenge for involved actors, and as Thunberg and Persson (2014) argue, approximately 60% of all material deliveries to construction sites fail to get there without damage, at the given time slot, in the agreed amount at the right place.

These different issues increase the difficulty to have well structured logistics on site, and increase the importance of the planning process in order to make sure that material arrives in a way that is actually manageable at the site (Agapiou et al., 1998). Agapiou et al. (1998) further mention that logistics in construction can span a wide range of activities with the ultimate focus of managing the process of material delivery, but also acknowledge the importance of logistics for the whole organization. For instance, it is described that: "logistics comprise planning, organization, coordination, and control of the materials flow from the extraction of raw materials to the incorporation into the finished building" (Agapiou et al. 1998, p.132).

2.2.1 Transports as a part of construction logistics

Based on the fact that a constant flow of material is vital for a construction project to progress, it could be argued that the construction industry is very dependent on

transport services (Sezer & Fredriksson, 2021a). Depending on the size of the project the number of deliveries varies, but in a large project, upwards of 100'000 transports is not uncommon during the construction phase (Dubois et al., 2019). As Sezer and Fredriksson (2021a) argue, low efficiency regarding material transports within the industry stems from poor planning and management of logistics among involved actors. There is often no set framework for how transports should be managed in the construction industry, the logistical approach needs to be tailored to the specific project.

In general, the transport industry is widespread in society and within many industries a lot of repetition and knowledge is in place. Hence, there is often a predetermined structure with set routes for transports within, for example, food and retail but this is not the case within the construction industry (Guerlain et al., 2019). Following this, Guerlain et al. (2019) identify that the approach used when delivering material to a construction site often varies, both regarding the type of vehicle as well as how it is packaged. However, Guerlain et al. (2019) emphasize that large lorries are the most common type of vehicle together with the use of pallets which is the most common load carrier. Sezer and Fredriksson (2021a) also describe that the large variety regarding what is produced creates different needs for ways of transport, still, it is described that when building houses most projects follow the same pattern when it comes to material delivery. In an early stage, it is often the case that excavation mass makes up most of the transported material, while pallets and smaller packages are common when the project has reached a later stage (Sezer & Fredriksson 2021a).

According to Ying et al. (2018), it is common for material suppliers to price material with the transports included, and therefore it is the material supplier that has the agreement with the haulier. Sezer and Fredriksson (2021a) also describe that this has been the typical approach for how the transport is agreed upon, resulting in the supplier needing to coordinate with the one driving the lorries. This, together with the high level of fragmentation and low exchange regarding details for the transports, causes unnecessary waste of both resources and material (Sezer & Fredriksson 2021a).

By being project based, and due to the fact that construction work is performed in various places, the transport services need to be constantly adapted (Ying et al., 2018). The inflow of material needs to be tailored to the specific construction site, for instance, Agapiou et al. (1998) describe that if the material is transported to the site in large quantities, damage and waste can occur if the material is not stored properly, causing delays as a consequence. In addition to limitations on the site, such as lack of space and risk for damage (Agapiou et al. 1998), Sullivan et al. (2010) describe that it is common for material deliveries to be limited by the prerequisites in the project's surrounding area. Especially when performing construction in dense urban areas, deliveries of materials need to work alongside other infrastructure that is in place in the cities (Sullivan et al. 2010). Guerlain et al., (2019) describe in their study that it is common for material transports destined to construction sites in city areas to get stuck in traffic when performing a delivery.

2.3 Logistics solutions with a potential of reducing the environmental impact from construction transport

In order to reduce the environmental impact, there are several aspects that need to be considered. One of them is how a project is handling its logistics. It could be managed in various ways, hence there are many solutions, and there are advantages and disadvantages in all of them. Sezer and Fredriksson (2021a) describe that different logistical approaches can have an impact on the environmental performance of a project and are therefore important to validate.

2.3.1 Third party logistics provider - TPL

Within the construction industry, it is common to work with outsourcing for different activities in the building process when performing a temporary project. Logistics activities, on the other hand, have historically not been seen as value adding activities and thus not gained much attention. Now, in large and increasingly complex projects, the idea of outsourcing logistic activities and transport planning is starting to gain ground (Fredriksson et al., 2021a).

In other industries, companies working solely with managing logistics and transports are not uncommon, but it is only during the last few years that these actors have started to get involved in the construction industry (Ekeskär & Rudberg, 2016). This is mainly due to the complex nature of construction projects and their constantly evolving supply chains (Ekeskär & Rudberg, 2016).

These types of companies, who work manly with logistics, are often referred to as third party logistics providers or TPLs, and they can be involved to a varying degree (Ekeskär & Rudberg, 2016). They can have a smaller role, for example, managing transports to the site and making sure that off loadings are managed in a good way. In addition, they can also be more involved and in charge of managing the whole logistical setup for a project, handling the contact and planning with different suppliers, and structuring all access to the site (Ekeskär & Rudberg, 2020).

The lack of structure and management of the supply chain is often identified as one of the reasons for the low productivity in the construction industry. Construction projects often have their own specific characteristics and therefore it is difficult to reuse previous setups. In the same way, the suppliers of logistics services need to constantly adopt their offering to be suitable for the current project since no two projects are completely alike (Fredriksson et al., 2021).

Furthermore, Ying et al. (2018) highlight that an evident issue is that companies tend to lack information regarding their costs for transports and logistics. When purchasing material suppliers tend to set a price that includes the delivery to a specified location, and thus it is difficult to separate the material cost from the transport (Ying et al., 2018). Therefore, it is sometimes argued that including a

dedicated actor for handling logistics is seen as an additional expense, however, Ekeskär and Rudberg (2020) claim that costs can be reduced when the logistics solution is well handled by a specialized actor.

2.3.2 Construction consolidation centers

Another approach that is increasing in popularity within the construction industry is construction consolidation centers (Sullivan et al., 2010). This strategy is commonly referred to as the use of a consolidation center (CC), a construction logistics center (CLC), or a construction consolidation center (CCC). The overall goal with these approaches is to reduce the congestion at the construction site as well as lowering the number of transport that has to access the construction area. Also, by planning all deliveries to a logistics center, some level of security is introduced regarding the supply of material. By receiving material to a consolidation facility a few days prior to when it is needed on site, the risk of causing delays based on faulty or wrong material is reduced (Sullivan et al., 2010). The center is typically located in close proximity to a construction site that is utilizing its services, or further away with a checkpoint close to the site (Janné & Fredriksson 2019). Guerlain et al. (2019) highlight that the location of the CCC should be agreed upon by the construction companies involved together with the municipality.

Despite the benefits, far from all projects use these types of solutions. An issue is that a consolidation center is sometimes portrayed as a cost saving measure, while in fact causing increased costs related to material handling (Janné & Fredriksson 2019). The implementation of a consolidating center requires resources, both regarding the actual facility and the workforce handling deliveries as well. This cost can also be seen as "new" since there is often a lack of knowledge regarding specific logistics costs because it is sometimes bundled together with material costs (Ying et al., 2018). Also, as Sullivan et al. (2010) claim: "there may be a perception that a CC is in some way planning for failure"(p.92). Consequently, the fact that the construction industry is generally slow to adopt new approaches is also a major obstacle for using different logistics centers to a larger extent.

In addition to assisting in smoothening the process of receiving material, consolidation centers also provide possible environmental benefits by reducing the number of transports that have to access a site that may be located in a dense city area (Guerlain et al., 2019). Guerlain et al. (2019) highlight the need to investigate and try out different solutions in order to achieve a more sustainable process. Following this, it is stated that the reduction of pollutant emissions from using a CCC is strongly connected to the characteristics of the project. Some projects are able to benefit more from the solution and thereby, reduce their number of transports to a larger extent. Still, Guerlain et al. (2019) conclude that there is a great potential for achieving a more sustainable situation of deliveries to construction sites by using consolidation centers. In the same way, Janné and Fredriksson (2019) present a case study where a CLC is tested in several projects in Sweden and conclude that some projects most certainly are able to reduce their environmental impact by implementing a CLC.

2.3.3 Just in time deliveries

The concept of just in time deliveries (JIT) is an emerging way of working with the transport of material to the construction site (Sezer & Fredriksson, 2021a). This method originates from the company Toyota in Japan and has played an important role in the manufacturing industry for many years (Pheng et al., 2011). Instead of storing a large proportion of the needed material on the actual site, this method advocates that material supply should be delivered not until it is supposed to be used in production (Sullivan et al., 2010). As Sullivan et al. (2010) describe, there are several benefits of introducing JIT, for example, it reduces the time that skilled construction workers have to spend moving material around on site, less resources need to be spent on storing material and consequently, there is less risk for material damage during storage.

To achieve these benefits, the planning of the ordering- and construction processes needs to be performed in symbiosis (Sezer & Fredriksson, 2021a). If there is a lack of joint planning it is difficult to increase the performance by implementing JIT as a strategic tool. Also, a potential problem with JIT deliveries is the high dependability on all stakeholders within the supply chain (Sullivan et al., 2010). If only one actor within the supply chain suffers from any inconvenience which causes delay, everyone who is waiting for material will suffer. Correspondingly, the fact that the construction industry is based on temporary workplaces, many unpredictable factors will affect planning, and therefore the possibility for just in time deliveries (Sullivan et al., 2010). When delivering material to a construction project, sudden events such as poor weather conditions or traffic congestion are impossible to fully plan for.

2.3.4 Checkpoint

Another way of controlling deliveries to the construction site is through a checkpoint. The objective of using a checkpoint is to handle the flow of deliveries to the site in a strictly managed way. By setting the requirement that all truckloads destined for the site pass through the checkpoint, the risk of congestion at the delivery space, on site, reduces (Ekeskär & Rudberg, 2016). When using a checkpoint, the deliveries can be checked before arriving at the site, and it can also be assured that all the necessary unloading equipment (crane, telescopic handlers, etc.) are available for use. What should be noted is the difference between a consolidation center and a checkpoint. As described previously, a consolidation center focuses on consolidation material and offers temporary storage. A checkpoint, on the other hand, does not revolve around storing material, it is rather an enabler for smooth deliveries to the site in specific time slots, i.e JIT deliveries (Janné, 2018). The checkpoint can be placed near the construction site or further away, it can also be used in a fully fledged construction setup together with other systems such as consolidation centers (Janné, 2018).

2.3.5 Delivery containers

During the production phase, there is a large need for consumable materials and other smaller items. Different contractors on site order their own smaller items and therefore they need to coordinate when receiving the deliveries (Dubois et al., 2019). This can cause congestion on the site since different carriers need to find the one responsible for the delivery, causing unnecessary journeys and time waste. This can be solved by utilizing smart delivery containers (Sezer & Fredriksson, 2021b). This is a small storage facility that is placed on the boundary of the construction site and thus accessed from the outside. In this way, small materials can be ordered and delivered around the clock if the carrier can digitally open the container (Sezer & Fredriksson, 2021b). The one who has ordered the material can receive a confirmation when the material is ready for pickup in the container. In this way, the suppliers and carriers can structure their deliveries more freely and thereby achieve higher efficiency.

2.3.6 Transport purchases - a guideline for a reduced climate impact

The County Administrative Board has issued a publication including guidelines for transports, which is also applicable for the construction industry. The document separates what type of demands the transport purchaser, as well as the material buyer, should set (Länsstyrelsen Västmanland, 2021). Still, it is described that it is not only the transport buyer, who is in direct contact with the haulier, that should set the requirements for the transports, material purchase also needs to be knowledgeable and set the right demands when they buy material with an included transport (Länsstyrelsen Västmanland, 2021). Therefore, one aspect of the guideline is to illustrate how the different actors in the chain can affect the possibility for climate friendly transports. For instance, the guideline states that the purchaser who receives the transports can be included and set requirements regarding co-loading, time frames for delivery and planning, and choice of transport type (Länsstyrelsen Västmanland, 2021). They should also strive to be included in a process of systematically planning for more sustainable transports.

Regarding the possibility to introduce a larger number of environmentally friendly vehicles, several criteria are highlighted as important but most of them are directed toward transport purchasers (Länsstyrelsen Västmanland, 2021). For instance, it is claimed that a good approach is to have long term contracts with the hauliers, increasing their security and incentive for new environmentally friendly vehicles.

Furthermore, the use of a consolidation center is described as a solution that can reduce both the emissions from transports as well as the energy usage (Länsstyrelsen Västmanland, 2021). The implementation of a consolidation terminal is described to handle the same amount of transported goods but through a lower number of driven vehicle kilometers, consequently, achieving a higher utilization rate of the vehicles.

2.4 Procurement and contract relationships

The contract between those involved in the project sets the framework for what should be performed and to what cost. The process of procurement creates the contract and a link between everyone involved in the supply process and therefore, the process of procurement plays a vital role in the industry (Ruparathna & Hewage, 2015). Within the Swedish construction industry, there are two main types of procurement approaches that regulate the relationship between the client and the involved actors, divided- or general contract (Boverket, 2021e). In the case of a divided contract, the client themselves procure different contractors needed in the project. The other approach, the general contract, revolves around one main contractor that is procured by the client, then, this main contractor involves subcontractors needed for the project.

In Sweden, there is a law in place that regulates public procurement, i.e procurement of projects when the client is a publicly owned entity such as a municipality, or governmentally owned company (SFS 2016:1145). The objective of the regulation is that every contractor that is interested in a project should be able to participate and submit a tender. The client, in this case, a public actor, sets a number of criteria for the project, and then everyone can submit a tender. It is also important that the client sets reasonable demands that are relevant to the project and does not favor any specific actors, the objective is to favor competition and consequently high demands can reduce the number of companies that can or will participate (Konkurrensverket, 2021). The public actor should then choose the one that submits the lowest tender (assuming they all meet the set criteria). This approach also makes it possible for the client to set demands regarding a lower environmental impact, for example if, procuring transport services, a procurement criteria could be focused on how low emissions the supplier can show for the provided transport service (Upphandlingsmyndigheten, n.d).

The procurement and contract type also sets the boundaries for responsibility and level of collaboration between actors. The client can procure a contractor for all parts of the process, i.e through a contract where the contractor performs the design and the construction (Morledge & Smith, 2013). Another way is that the client themselves performs the design and then procures a contractor for the actual construction. These two ways of working are the two most common in Sweden, and are often referred to as Design-Build, and Design-Bid-Build (Boverket, 2021). In addition, there are several contract types with a varying degree of collaboration between the parties, such as partnering and different variants of it (Morledge & Smith, 2013). Gadde and Dubois (2010) describe partnering as a contract with a collaborative approach and this type of contract form can take place at different levels in a company. Partnering could be established at the project level among the actors involved on site, but it can also be developed in a more strategic way. Furthermore, Gadde and Dubois (2010) explain that the structure of an organization is a key factor to take into consideration when evaluating if a collaborative contract such as partnering will be a success or not.

2.5 Climate goals in Sweden

In order to progress towards a sustainable environment the parliament developed a framework in 2017, for climate politics in Sweden. The long term goal is that Sweden should be climate neutral in 2045. For different sectors and industries, several sub-goals have been developed (Naturvårdsverket, n.d.b). This framework consists of three sub-parts, a climate law, climate goals, and different climate-political advice. The new regulation gained legal force on the 1st of January 2018 and thereby demanded that the parliament act according to the set goals and continuously report on the progress. A central consideration within this law is that budget- and climate goals should be equally important and correlated. Each year, the parliament should declare what initiatives that have been taken during the year and if there is any need for additional measures (Naturvårdsverket, n.d.b). Furthermore, the law also states that the parliament should on a four-year basis develop a political plan of action regarding climate politics with the goal of illustrating the joint effort by the parliament to work against the different long term objectives.

Moreover, to evaluate the current status of the climate work, different goals have been set in order to assist the transition towards net-zero emissions in 2045. One of these revolves around the domestic transport sector where the target is to reduce the CO_2 emissions by 70% until 2030 (compared to levels from 2010). Although, according to the Swedish Transport Agency, the current rate of reduction in CO_2 emissions is only 2% per year and at this rate, the goals will not be reached (Trafikverket, 2020).

2.6 Climate declaration

During many years the Swedish National Board of Housing, Building and Planning has evaluated the environmental impact of the Swedish construction industry (Boverket, 2020). Goals have been set that Sweden should be climate neutral by 2045 and the construction industry has been identified as an important sector to develop. Therefore, in 2018 the Swedish National Board of Housing, Building and Planning reviewed a request from the Swedish parliament to assess the possibilities for achieving a more sustainable construction industry, also they were asked to evaluate the possibilities to demand a climate declaration when constructing new buildings (Boverket, 2020).

In the following year, the Swedish parliament tasked the Swedish National Board of Housing, Building and Planning with initiating and preparing for the use of a compulsory declaration for the construction of new buildings (Boverket, 2020). This work included five different steps consisting of developing a database with typical construction material and their climate impact, evaluating what should be included in the declaration, developing information and guiding documents as well as establishing a roadmap for implementation.

Mid 2021, the Swedish parliament passed a new legislation based on the prepared

work by the Swedish National Board of Housing, Building and Planning. The law stated that all new buildings that seek a building permit after the 1st of January 2022 should be accompanied by a mandatory climate declaration that illustrates their environmental impact (Boverket, 2020). Consequently, actors must adhere to and undertake the required actions in order to fulfill the new requirements.

2.6.1 The purpose of climate declaration

The overall aim of implementing a mandatory climate declaration is to reduce the environmental impact of the Swedish construction industry. It is identified that the Swedish construction industry represents approximately 20% of the total climate impact for 2018, where one third of this comes from the construction of new buildings (Boverket 2021f). Furthermore, the new regulation strives to accomplish several strategic criteria in order to attain the overall aim. The first one focuses on increasing the knowledge regarding a building's environmental impact (Boverket 2021f). Different actors within the industry have expressed that they see a lack of different policies to create a competitive playfield striving for a more sustainable industry. By demanding a climate declaration, it will become evident which construction materials, building methods, or types of construction are favorable from an environmental standpoint. Secondly, there is different legislation in place regarding the maximum energy use during a building's operational stage, but there are still no limits for emissions during the construction phase (Boverket 2021f).

Therefore, by creating a climate declaration the emissions from the construction phase will become evident and consequently act as a first step towards lowering these emissions. The climate declaration aims solely on illustrating the emissions during this first step, thus there are no set values for emissions yet (Boverket 2021f). The Swedish National Board of Housing, Building and Planning has made a proposal, which is that in 2027 there should be limits for emissions from a building's construction phase (Ministry of Finance, 2022). However, the Swedish parliament has assigned the Swedish National Board of Housing, Building and Planning to assess if these limits could be implemented earlier than 2027 and if there are additional areas where the climate declaration could be applied.

2.6.2 Buildings covered by the regulation

Based on the new law accepted by the Swedish parliament, clients that apply for a building permit after the 1st of January 2022 need to provide a climate declaration when applying for a final clearance (Boverket, 2021g). Although, there are a few exceptions when clients don't have to create a climate declaration, and they are:

- Are built on a temporary building permit with a use time of maximum 2 years.
- Buildings that don't require a building permit.
- Buildings intended for industry and workshop use.

- Farm buildings intended for agriculture, forestry and similar use.
- Buildings with a maximal gross floor area of 100 square meters
- Constructions intended for the national defense of Sweden
- Buildings constructed by certain governmental clients.
- Buildings where a private citizen is the developer and the building is not intended for commercial use.

All other buildings should be accompanied by an approved climate declaration in order to be able to receive the final clearance required to start using the building (Boverket, 2021g).

2.6.3 Sections within the climate declaration

The lifecycle of a building is according to the European standard EN 15978 divided into three stages which are the construction stage, the usage stage, and the end of life stage (Boverket, 2021h), as illustrated in Figure 4.

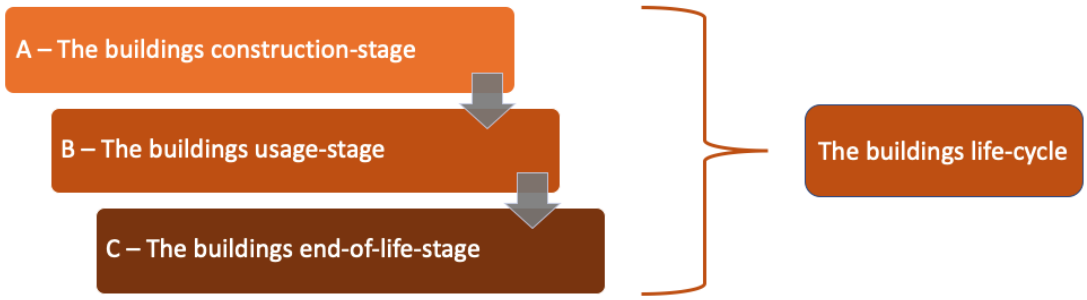

Figure 4: An illustration of the buildings life-cycle

While all stages are important, the climate declaration is created to enhance the knowledge regarding emissions from the construction stage, which includes stages A1 to A5. Stage A1 to A3 focus on the production of materials and the following two, A4 and A5 contain information regarding the transport of material to the construction site and the building process on the construction site (Boverket, 2021h).

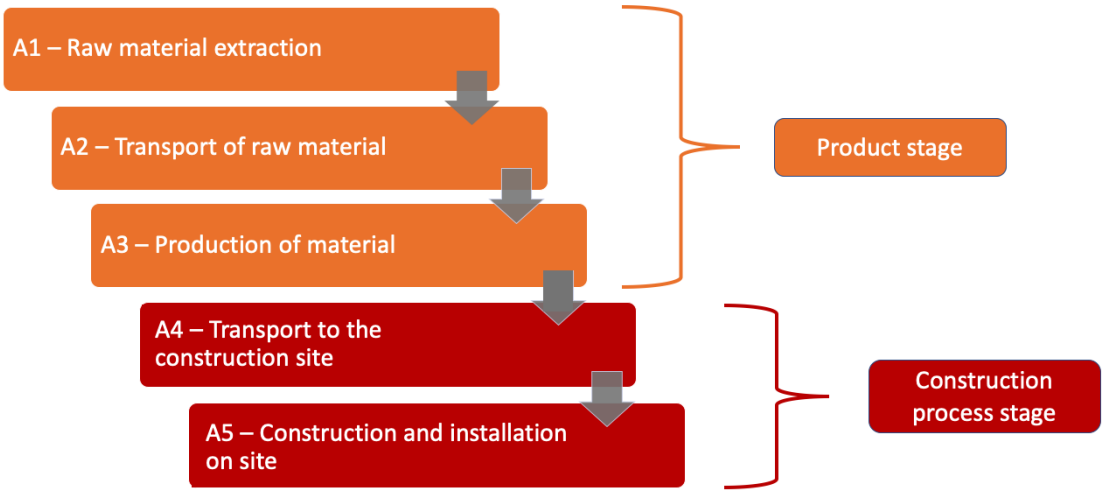

Figure 5: All stages included in the climate declaration

Based on the aim of this research, the stage in focus is A4 which focuses on transports to the construction site. This section will be described in detail in the following section.

2.6.4 Stage A4 – Transports to the construction site

Stage A4 within the climate declaration should contain information regarding the climate impact from transports that deliver material between the place of material production to the construction site (Boverket, 2021i). This stage only incorporates materials for the construction of the building, and the different materials that are included are the following:

- Material for the load bearing structure
- Material for the climate screen
- Material for interior walls

Hence, transports of additional building products, consumable material, machinery, and temporary establishments should not be included within stage A4. The purpose of this particular stage is to increase awareness and illustrate the climate impact from transports (Boverket, 2021i). This is done in order to illustrate possibilities to reduce the climate impact from different processes. Also, the goal is that this knowledge should motivate actors to focus on reducing their emissions by choosing suppliers in close geographic proximity or by demanding certain types of fuels or vehicles.

The Swedish National Board of Housing, Building and Planning has created a framework to assist the creation of the climate declaration, for step A4, they present two different approaches for the calculation of the climate impact from each product.

The first alternative focuses on actual data, specific for the project, data such as actual distance for the deliveries, what type of vehicle, what type of fuel, and fill rate (Boverket, 2021i). Then, based on these numbers, the Swedish National Board of Housing, Building and Planning provides a climate database for fuels and energy. For the second alternative, generic climate data for common construction materials are predetermined. When using this for the calculation, the database that the Swedish National Board of Housing, Building and Planning has developed for section A4 should be used. The generic values are based on typical scenarios and transport distances, and by performing actual calculations in line with alternative 1, more precise values can be achieved. This assists in providing a more accurate number for the emissions from transports and could favor those who perform calculations (Boverket, 2021i).

2.7 Environmental impact from transports

Within Sweden, one third of all greenhouse gas emissions stem from domestic transports (Trafikverket, 2021a). Even though there are a lot of different types of ways of transport such as air, road, and rail, road transport is the most dominant with regards to emissions and represents 90% of all emissions within the transport sector. The reason for this is that fossil fuels are the prevalent source of energy for road vehicles. According to the Swedish Environmental Protection Agency, there are three main ways to reduce the environmental impact from the transport sector; reduce the number of transport kilometers, increase the energy efficiency for the transports, or reduce the amount of fossil fuel used as an energy source (Naturvårdsverket, n.d.a).

2.7.1 Different vehicles and fuels

In 2018, the Swedish transport fleet consisted of approximately 84 000 heavy vehicles, where almost 82 000 of these were powered by diesel (Trafikanalys, 2019). Furthermore, when registering a vehicle in Sweden there is no requirement to state whether the vehicle can be driven on biodiesel or not. This makes it difficult to assess how large a portion of the vehicle fleet that can be driven on new, fossil free diesel alternatives.

During the last few years, the increased understanding of the importance for a sustainable future has influenced suppliers of heavy vehicles to develop new alternatives to the traditional diesel engines. For example, in 2021 Volvo trucks revealed that they are launching a complete fleet of heavy lorries with a fully electric powertrain (AB Volvo, 2020). Moreover, Volvo states that in the coming years that they will continue developing electric lorries suitable for longer and heavier hauls. Also, they will develop hydrogen powered powertrains suitable for lorries. Volvo's goal is that their production of heavy transport vehicles should be completely fossil free by 2040.

It will most certainly take time to transition the whole fleet of transport vehicles to new types of fuels, and consequently, there will be a long period where multiple types of lorries will be used. In order to make the fossil alternative successively better

during this transition period, the parliament has decided for a yearly reduction rate for diesel which aims at reducing the emissions from the fuel (SFS 2017:1201). The latest adjustment took place on the 1st of January 2022 when diesel is supposed to contain 30,5% renewable content. This is claimed to be one of the most powerful policy instruments in Sweden today since it forces an increased use of renewable fuels (Ministry of Infrastructure, 2021).

3 | Methodology

The method chapter describes how the research has been carried out and methodological standpoints. In the first section, 3.1, the research process is described in detail, followed by 3.2 which presents the research methodology. Furthermore, in 3.3 it is explained how the empirical data was gathered, including the process of finding interviews. A reasoning concerning the trustworthiness of the research is developed in 3.4. Finally, a reflection from an ethical and sustainability point of view is outlined in part 3.5.

3.1 Research process

The idea behind the research originates from the new requirements regarding the demand for climate declaration for new buildings. To evaluate the current status of, and possibilities within, the Swedish construction industry, a collaboration with Serneke was developed. Serneke described that they have identified a lack of knowledge regarding the environmental impact from their transports of material deliveries. They further expressed a need to develop the ability to assess and adapt their way of working in order to cope with the new requirements. Consequently, the research was narrowed down and focused on the part of the climate declaration that affects transports of material. Since the interest was to create a result that was both rooted in research and applicable in practice, it was decided that the study would be based on a literature review and an interview study. This decision was made in agreement with Serneke.

For the theoretical frame, scientific articles, reports, and books have provided the main source of information. In addition, the Swedish National Board of Housing, Building and Planning and the Swedish Environmental Protection Agency have been used in the perspective of defining laws and regulations related to the Swedish construction industry. Various databases such as Chalmers library, Google Scholar, and Scopus have been utilized in order to collect reliable sources. Initially, a wide search for possible data was performed to get a comprehensive understanding of previous research within the field. The different sources were further examined and reviewed with the purpose of adding value to the studied topic. Finally, literature that contributed to the aim of the research was then selected. The theoretical gathering served as a basis for the theoretical frame thus creating a perception concerning issues and possibilities that could be investigated further. Moreover, the evalu-

ated theory assisted in formulating suitable interview questions, which facilitated the research by attaining as much applicable information from the interviewees as possible.

In dialogue with Serneke, several key roles for interviews were chosen, mainly within the company. To follow the aim of the research of finding applicable solutions, the identified roles consisted both of strategic functions within the company as well as operative personnel within some key projects. The different projects were also visited to provide some visual input to the logistical setup and work. The purpose was further to include several professions and perspectives within the company to find different viewpoints. In order to broaden the picture, an interview was also performed with a logistics specialist outside Serneke to gain some first-hand knowledge regarding possible issues and solutions within the industry. All interviews were semi-structured where a set of prepared questions were presented and discussed. Consequently, the interviewees were also given the opportunity to express their own thoughts and ideas. This possibility was provided with the intention of not missing insights into the interviewees day to day work.

In parallel with the interview process, the results were compiled and common themes were identified. The logistical setup from the studied projects was described more in depth, together with the insights from the interviewees. The findings were then analyzed together with the theoretical frame in order to answer the research questions. Lastly, the conclusion was formulated based on the reasoning in the analysis.

3.1.1 Data collection

The point of departure for the collection of empirical data was to identify which roles that would contribute to the study. In close collaboration with Serneke, it was decided that the most suitable strategy was to interview several key functions within the central organization, as well as people with project specific knowledge. To be able to compare the different understandings, and to find applicable results, it was also decided that a couple of projects should be investigated in more detail.

The interviews were performed in two different ways, they were either carried out face-to-face or digitally via Teams. All interviews were conducted in Swedish since this was a wish from the authors as well as the interviewees in order to not encounter any language difficulties. Having the opportunity to perform some of the interviews via Teams, contributed to an efficient and smooth process. Several interviewees did not have the time or possibility to attend a meeting physically and in those situations, it was appreciated that it still was possible to conduct an interview digitally. For the interviews carried out face-to-face the questions were not sent to the interviewee beforehand, except if they requested so, in order to enable a more realistic discussion. For all interviews performed digitally, the questions were sent to the interviewee beforehand with the purpose of not letting the digital setup hamper the discussion. In addition, to attain different viewpoints on the same issues the questions used in the interviews were based on the same general themes. By doing this, the questions were adapted to the role and knowledge of the interviewee while

still focusing on the same core issues.

3.1.2 The process of finding interviewees

Interview requests were sent out to roles that were assumed to be linked to transports and logistics. These interviews provide the study with the view of central functions within Serneke, the interviewee´s professions are presented in Table 1 below.

Table 1: Interviews with central functions within Serneke

Profession	Interview duration	Date	Interview setting
Purchasing Manager	60 min	2022-02-24	Digitally via Teams
HSEQ Manager	60 min	2022-02-02	Conducted on site
Environmental Health & Safety Coordinator	60 min	2022-03-03	Digitally via Teams
Purchasing Strategist	60 min	2022-03-16	Conducted on site
Project Purchaser	60 min	2022-03-16	Conducted on site
Quality & Environmental Strategist	60 min	2022-03-16	Conducted on site
Chief Sustainability Officer	60 min	2022-04-06	Conducted on site
Site Manager B	50 min	2022-03-30	Digitally via Teams

Since Serneke is involved in a wide range of construction projects, varying in both complexity and scale, three different projects were chosen. Each project represents a different level of complexness and size, hence, highlighting how logistics are managed in different settings. Consequently, the following projects were identified and presented in Table 2:

Table 2: Studied ongoing projects within Serneke

Project	Size (SEK)	Location
Karlatornet	4,5 billion SEK	Lindholmen, Gothenburg
Litteraturgatan	90 million SEK	Selma stad, Gothenburg
Handelshögskolan	800 million SEK	Vasastaden, Gothenburg

In order to establish contact with the most suitable person within the projects a description of the aim of the research was sent to project specific personnel. Based on this, one person in each project was recognized and asked to participate in the study. In this way, all project specific personnel were identified. In addition to the interviews, a short site visit was conducted with the intention to get an illustration and understanding of how the logistics were handled and more specifically, how the material transports were executed. In Table 3, the different professions that were interviewed are presented.

Table 3: Interviews within Sernekes projects

Profession	Project	Interview duration (including site visit)	Date	Interview setting
EPCM Engineer	Karlatornet	120 min	2022-03-07	Conducted on site
Site Manager A	Litteraturgatan	180 min	2022-03-22	Conducted on site
Project Manager	Handelshögskolan	75 min	2022-04-08	Conducted on site

When interviewing professions within the projects, additional key actors appeared as relevant. For example, since the logistics solution for Karlatornet is outsourced to a TPL, the ones that deliver this service were sent a request regarding an interview. In addition, a representative from the County Administrative Board that previously had been in touch with Serneke concerning how transports could be managed was contacted. The interviews performed with these external actors are presented in Table 4.

Table 4: Interviews with external actors

Profession	Organization	Interview duration	Date	Interview setting
TPL Manager	Ahlsell	75 min	2022-03-16	Digitally via Teams
Energy & Climate Coordinator	County administrative Board - Västmanland	60 min	2022-03-28	Digitally via Teams

3.2 Reasearch methodology

The study was based on a qualitative approach where the studied literature and empirical gathering was affecting each other. The characteristics of qualitative research revolve around investigating data that is not constructed out of numbers, rather the focus is on interpreting and analyzing words representing different understandings and opinions (Bell et al., 2022). According to Fossey et al. 2002, interviews are a common and suitable method in qualitative research. Since the goal of this study was to understand and evaluate how transports should be assessed and managed within Serneke, interviews were performed which strengthened the qualitative research approach used in the study. They were carried out both in person and digitally and what should be noted is that the interviews conducted in person appeared to foster better communication between the interviewers and interviewees. This enhanced the information exchange and gave deeper reasoning. Drawing from Bell et al. (2022), this could originate from the fact that body language and visual appearance can impact how information is communicated and perceived.

In order to facilitate the process, the study has been carried out with support from the steps within qualitative research described by Bell et al. (2022), which is illustrated in Figure 6. The research questions of the study served as a basis for the collection of theoretical as well as empirical data. The data was then carefully evaluated and interpreted, which made it possible to specify the research questions further. This process was performed iteratively which resulted in a discussion based on the findings.

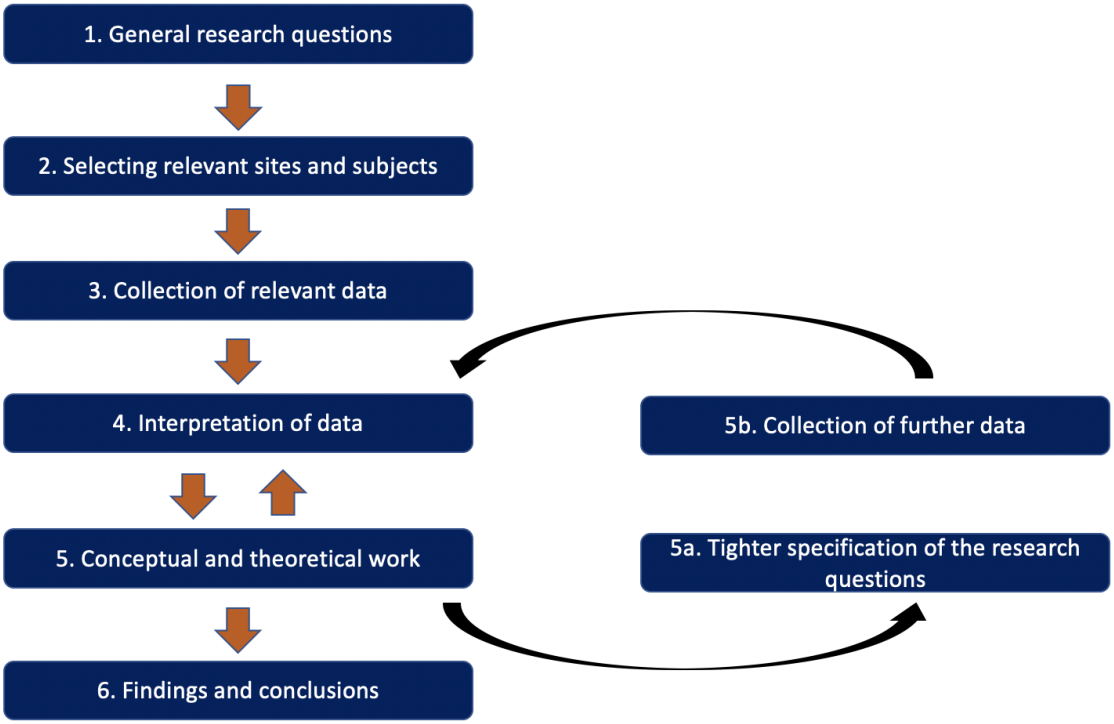

Figure 6: Main steps within qualitative research based on Bell et al. (2022)

Considering that the issue under investigation is dependent on many different factors it was difficult to define what theoretical and empirical information needed to be compiled and collected. Since the theoretical part affected the empirical data and vice versa as the study progressed, abductive reasoning was used. An abductive method is described by Dubois and Gadde (2002) as a research approach that allows that "the original framework is successively modified, partly as a result of unanticipated empirical findings, but also of theoretical insights gained during the process"(p.559). As a consequence, the process of working with existing theory alongside the collection of empirical data through interviews followed this method (Bell et al., 2022).

3.3 Research quality

As Bell et al. (2022) describe, the quality of a research based on a qualitative approach can be assessed by reviewing the trustworthiness of the study. The concept of trustworthiness can be divided into four different aspects which are credibility, transferability, dependability, and confirmability. The credibility of the study is ensured through the use of multiple data sources which have been synthesized. According to Bell et. al (2022) triangulation is an approach for ensuring credibility by using different data sources in conjunction, an approach that has been applied in this study. The use of peer reviewed scientific papers together with parliamentary websites delivered a trustworthy knowledge basis. Moreover, the interviews illustrated how the construction industry actually perceives the different problems

on an everyday level, the two data collection methods ensure the transferability of the study. Consequently, the two different data collection methods complemented each other and strengthened the validity. The presented findings were specific to the studied company and projects and should be seen as examples and ideas as opposed to facts. Bell et al. (2022) further describe dependability as how well the process is documented and can be replicated. This study achieves this by basing the findings on previous research. Lastly, credibility is based on the researcher's objectivity when performing this study (Bell et al., 2022). This is ensured since the study has been reviewed by an external reader.

3.4 Ethics and sustainability

During all steps within the research process, measures were taken to protect the identity and integrity of the interviewees, as well as get consent to use their information within the study. All interviewees are anonymous and only referred to as their work profession within their company. The interviews were recorded with permission from the interviewees and the recordings were only used by the authors and not shared in any way. In order to portray what the interviewees express in a correct and truthful way, the interviews were transcribed in their entirety.

In those cases where confidential information was shared with the authors, it was only used by the authors to gain deeper knowledge of the subject and not shared in the thesis. Information obtained during the site visits illustrated the overall setup of the logistics solution, no individual people that were observed were described. In addition, observations made on site regarding activities that fall outside the scope of this study were not further elaborated on.

The transport sector that supplies material to construction sites represents a considerable portion of the domestic emissions in Sweden. Hence, this research has a strong sustainability focus and takes the point of departure in the environmental issues that are related to transports within the construction industry. There is a strong need to develop new guidelines for how transports should be reduced and managed, both to cope with new requirements from The Swedish National Board of Housing, Building and Planning, but also to ensure that the set climate goals within Sweden can be reached and fulfilled. All these aspects will therefore be taken into account and reflected upon.

4 | Empirical findings

In this part, the empirical data is presented. The three ongoing projects within Serneke are described and their current logistic setup and environmental awareness are illustrated. Firstly, section 4.1 revolves around the project Karlatornet, secondly, section 4.2 describes the project Litteraturgatan, and lastly, in section 4.3, the project Handelshögskolan is examined. Moreover, part 4.4 explains how Serneke is structuring and managing transports today, and following this, the identified issues related to transports and planning are presented in 4.5. Considering the objective of the thesis, the interviewees' understandings regarding the new act for climate declarations are elaborated on in section 4.6. Furthermore, the different tools that the interviewees acknowledged as relevant for a reduced climate impact are outlined in 4.7. As a concluding part of the chapter, an external view on transport planning as well as Serneke's long term vision regarding their sustainability ambitions are presented in 4.8 and 4.9.

4.1 Karlatornet - a project within the district Karlastaden

The first project covers Karlatornet. The project is a key contribution to the newly developed district Karlastaden, which is located at Lindholmen in Gothenburg. Following the long term vision of Gothenburg city, the municipality has decided that the area should be developed in a sustainable way, considering economical, social as well as environmental aspects. Karlastaden aims to contribute to this concept by providing a combination of dwellings, offices, shops, restaurants, and various services thus resulting in a mixed city environment (Serneke,n.d.a).

Karlastaden covers approximately 32.000 square meters and Karlatornet is a landmark with a height of 245 meters (Serneke, n.d.a). The district will provide a mixture of different services and activities, and the estimated turnover is calculated to be around ten billion SEK in the following six to seven years after its completion (Serneke, n.d.a).

The tower is the first of its kind in the Nordic area, and when finished it will be the highest building in the region with a height of 245 meters and 73 storeys. Karlatornet will house a multitude of different services, such as shops, office-spaces as well as

private accommodations (Serneke, n.d.a). The tower has been in the making for a long time and in 2014 the American architectural firm Skidmore, Owings and Merrill won the architectural competition with their contribution "Polstjärnan" (Serneke, n.d.a)

4.1.1 Logistic solution/setup at Karlatornet

The logistic setup of Karlatornet is illustrated in Figure 7 below. According to the *EPCM Engineer* who is responsible for the logistic setup at Karlatornet, the material delivery process starts with transports from the suppliers to a construction consolidation center (CCC). All material handling on the CCC is outsourced and handled by a TPL provider. As the *TPL Manager* describes, the material should, in an ideal situation, be stored between a minimum of 1 and a maximum of 4 days at the center, after this, the material should be delivered to the site. In addition, it is mentioned that the CCC is used only for Karlatornet and not any other projects that Serneke is responsible for within Karlastaden. The TPL provider manages all material that is delivered to the CCC, as well as being responsible for handling the process of delivering the material from the center to the site. At the site, the TPL provider has established a checkpoint that is used for coordinating material deliveries when arriving at the site. According to the *EPCM Engineer*, only deliveries containing full truckloads of certain material are delivered directly to the site, whereas everything else should be consolidated at the CCC. The *EPCM Engineer* explains that a external haulage is contracted for the material deliveries from the CCC to the construction site, a trip that is made a couple of times per day. The *TPL Manager* further describes that they work very close with Karlatornets project organization with some sort of contact on a daily basis. In addition, strategic meetings are held where the process is reviewed.

Since the project is extensive and complex a comprehensive list of requirements regarding material handling and logistics has been compiled in a logistics appendix. This document illustrates how material and other deliveries should be managed and handled. The appendix also describes the responsibility of those involved. According to the *EPCM Engineer*, this document is included in all supplier agreements as a mandatory set of requirements. When new actors get involved, a start up meeting is held where the different aspects are discussed and described in detail. Furthermore, the *EPCM Engineer* describes that they use a system called Myloc for all logistical planning, this tool serves as the framework for planning and managing material at the consolidation center but also on the site. All material deliveries should be documented in a cloud based logistics software and be booked for delivery through the system.

Although the logistic appendix serves as a tool for ensuring that the logistics within the project are managed in the right way, the *EPCM Engineer* expresses that it doesn't reflect reality in many situations. Still, the *EPCM Engineer* does not think that the ambitions set in the appendix are too high, but that they rather should be seen as goals for handling logistics. Still, all material flows are strictly controlled within the project. For example, when the material is purchased, the date of delivery

is scheduled immediately.

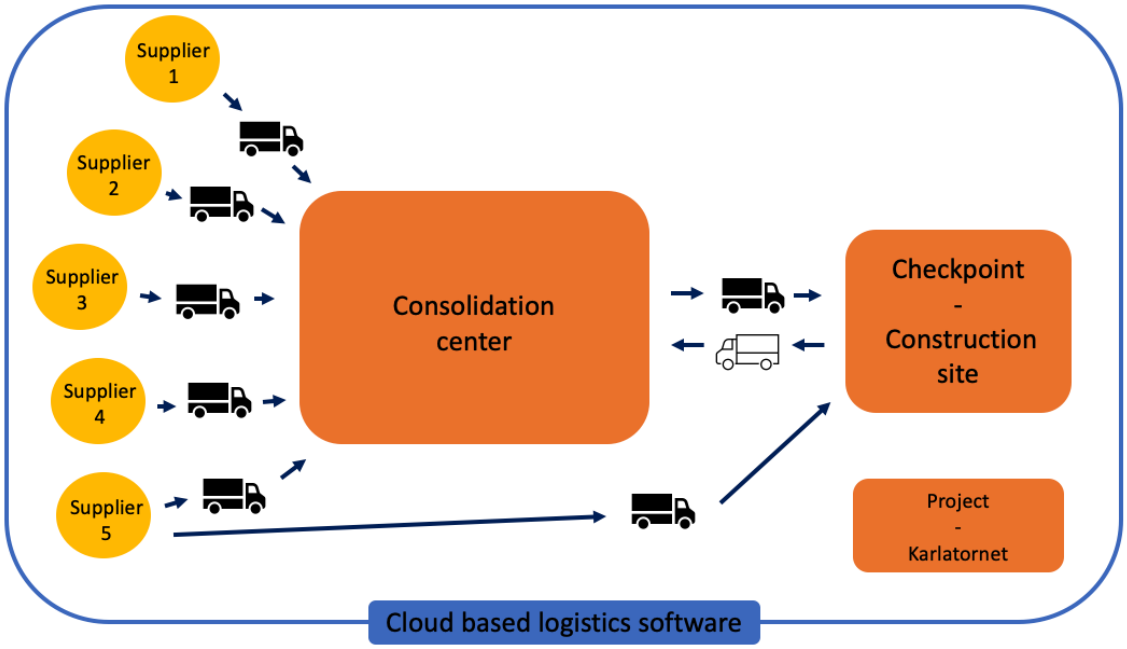

Figure 7: An illustration of the logistic setup at Karlatornet

4.1.2 Environmental awareness regarding transports in project Karlatornet

Regarding the work with sustainability and issues related to the environmental impact from transports, the *EPCM Engineer* states that there are effectively no ongoing discussions about it. The *TPL Manager* emphasizes that this is the case and expresses, in accordance with the *EPCM Engineer*, that the priority of the developed setup is to achieve a well-functioning operation, whereas the environmental impact tends to be neglected. However, the *TPL Manager* further mentions that this setup is a "green solution", due to the ability to control the deliveries in a precise way. In a project which operates without a consolidation center, it is generally not possible to achieve the same precision regarding time slots for deliveries.

When the material is purchased, and transports are scheduled, the primary goal is to guarantee a smooth operation and if this results in fewer transports and a lower environmental impact it is rather just a bonus. Consequently, the objective of the logistics appendix is to make it easier for the production activities to take place, it is uncommon that the environmental impact is the main reason for different decisions according to the *EPCM Engineer*. Also, the logistics appendix does not mention any considerations regarding emissions or environmental requirements that suppliers should obey when they deliver material or provide transport services. According to the *EPCM Engineer*, the reason for this is that if you want to set specific requirements, such as regulating what type of transport vehicles or fuel the suppliers should use, the cost will increase. The common way is that the cheapest option is opted

for, and there is generally a low possibility to adopt other, more costly options, even if they are more environmentally friendly.

4.2 Litteraturgatan - a project within the district Selma stad

The second project within Serneke that was examined is called Litteraturgatan and is a part of the new district Selma stad that is currently being developed in the northern part of Hisingen in Gothenburg (Göteborgs stad, 2022.). The area is planned to be finished in 2023 and the goal is that the area should provide a mixture of services. Within the area over 1700 new apartments will be built, where some are available for purchase and some for rental (Göteborgs stad, 2022.). In addition to accommodations, the area will house shops, cultural buildings, squares, and other facilities.

Selma stad is divided into various parts and the studied project that Serneke is responsible for is named block 11 and is placed along Litteraturgatan (Framtiden Byggutveckling, n.d.). According to the interviewed *Site Manager A*, the project is performed as a Design-Build, procured through a public process, and composes 60 apartments of different sizes and the total project sum is calculated to be around 90 million SEK. The area along Litteraturgatan will house 11 blocks in total and the goal is to produce 700 accommodations in various forms (Framtiden Byggutveckling, n.d.). The area will provide student housing, townhouses, as well as condominiums, and rentals. A key consideration in the development of the space is to foster the green environment that has always been associated with the area, and the focus when designing the streets is to make them attractive for pedestrians and for those living in the area (Framtiden Byggutveckling, n.d.).

4.2.1 Logistic solution/setup at Litteraturgatan

Site Manager A describes that the project approaches logistics and transports in a traditional way, all material is delivered directly to the site as illustrated in Figure 8. The project has no external actor that assists with the logistics management, instead, it is all handled by the people on site. When different components are procured a time slot for delivery is generally set long before the delivery is scheduled to take place. *Site Manager A* highlights that a prerequisite for this solution to be functional and smooth is to develop clear contracts with the suppliers. The involved actors should in an early stage agree upon the terms for the project to avoid inconveniences in the workflow in case of delays or other interruptions. Moreover, *Site Manager A* explains that if this is done in a proper way, the project is much more likely to succeed with just in time deliveries.

Furthermore, *Site Manager A* describes that when a transport is approaching the site, the driver should inform the site management approximately 15 minutes before they arrive at the site in order for the personnel on site to have time to prepare for the delivery. Also, when large trucks access the site, they need to reverse through

the gate since there is limited space. *Site Manager A* explains that it is not possible for them to drive through the site and as a consequence, this requires site workers to assist with this maneuver which is time consuming and interrupts their ongoing duties.

During the initiation of the project, it was discussed whether or not they could set up a storage tent for material on the site. However, due to the conditions on the site, it was impossible to implement such a solution according to *Site Manager A*. Since the site is rather small and has limited space for material storage, only key components were allowed to be stored for shorter periods. *Site Manager A* highlights that this could be for example if a delivery truck from a supplier has excess space on the truck, they could carry some additional material which is beneficial both from a construction and environmental perspective.

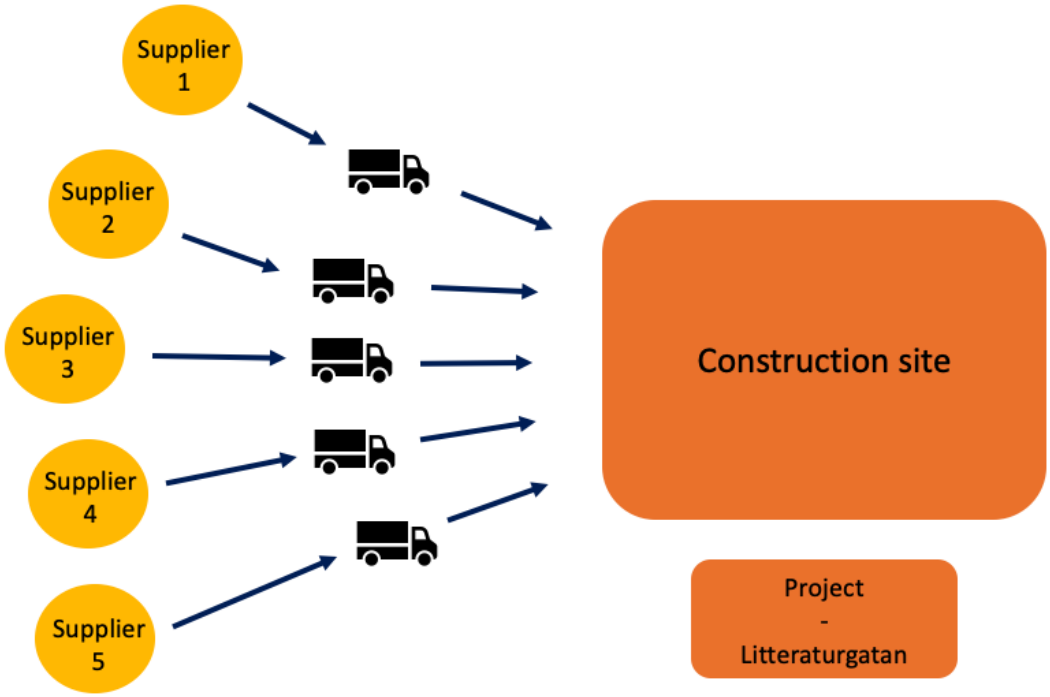

Figure 8: An illustration of the logistic setup at Litteraturgatan

4.2.2 Environmental awareness regarding transports at Litteraturgatan

Site Manager A mentions that the project was a part of Serneke's internal work with sustainability with a special focus on an environmental production site. It serves as a pilot project for a new environmental labeling that Serneke is developing for use in their projects. It was explained that this system rates different decisions and depending on if you make an environmentally friendly choice or not, the project receives different scores for various parameters. Depending on the total score, the project can be labeled in three different ways. The lowest level is bronze, which

also is a minimum requirement and if the project performs over this level it can receive either a silver or gold label. *Site Manager A* further describes that this way of working improved their knowledge and understanding regarding possible solutions and their environmental impact. Although this labeling is delimited to the activities that take place on site, the way of thinking has to some extent affected other activities according to *Site Manager A*.

Regarding transports to the site, *Site Manager A* mentions that they do not have any specific environmental demands on their transports, and since the project is a project of a public process, the strong price focus has in some instances caused longer transports than needed. Since the project is placed in Gothenburg they have to obey the requirements set by the city of Gothenburg. Due to the fact that most material is purchased with deliveries included, it is difficult to affect and set demands on the transport according to *Site Manager A*. Still, they had managed to work closely with some key suppliers which made it possible to co-load some material, and thereby utilize the full capacity of the truck. From the perspective of *Site Manager A*, this was mainly done in order to ensure a smooth operation on the site, and to reduce the resources needed for handling additional deliveries.

4.3 Handelshögskolan - a project within the district Vasastaden

Handelshögskolan is a university located in the center of Gothenburg. In order to provide adequate space for both students and teachers, the university is expanding its facilities. Today, the university uses facilities scattered around the city, and by constructing this new space, the area is to gather more functions in the same place (Akademiska hus, n.d.). It will provide the university with a new entrance, areas for lectures, office spaces, a cafeteria, and other student services. Also, the purpose is to develop the research department within economics and law. In addition to the spaces dedicated to the university, the building will house an entrance to the newly developed station called Haga kyrkogata along the newly developed Västlänken. The design of the building was set through a design competition in 2015, the winning contribution is called Annex and is produced by Johannes Norlander Arkitektur (Akademiska hus, n.d.).

The building will compose 7 storeys above ground and two cellar floors, and a gross floor area of approximately 12 000 square meters (Serneke, n.d.b). The project is performed by Serneke's two divisions, Serneke building, and Serneke infrastructure through a collaborative contract with Akademiska Hus. The *Project Manager* mentions that the total sum for the project is calculated to be 800 million SEK, which includes both the construction of the building and the entrance to the station. The *Project Manager* states that the project was initiated in 2020 by demolishing the existing building, and in 2021 the groundwork started. The *Project Manager* further mentions that since the construction includes a pathway to the new station Haga kyrkogata, a lot of work has to be performed below ground. This is also the current

status of the project, where the objective is to start construction of the building in a couple of years.

4.3.1 Logistic solution/setup at Handelshögskolan

This project is at the time of this study in an earlier stage compared to the previously described projects, the current deliveries include mostly concrete, steel, and reinforcement. Still, many relevant observations and findings were discovered regarding the logistic setup and transports within the project. The *Project Manager* explains that they had extremely limited space on the construction site. Almost no material was able to be stored on the site, and only one lorry could be placed within the gates. Also, all material deliveries were done by utilizing the tower crane on site. The *Project Manager* describes that they required very large amounts of steel in different forms in order to support the excavation, and since they could not store it on site, they used an off site storage solution for the steel.

In contrast to the steel deliveries, smaller items were ordered directly to the site in a traditional way as illustrated in Figure 9. However, The *Project Manager* mentions that they had one person who was responsible for material orders and everyone who needed material, forwarded this request to this person. This was done with the intention to reduce the number of transports that were driven to the site to utilize the resources available as much as possible.

To structure the transport of excavation material away from the site, an external logistics planner had been included to develop a structured plan for how this setup should operate according to the *Project Manager*. This plan was split into several different parts depending on the stage of the project, and the goal was to make the transport away from the site as smooth as possible. The *Project Manager* also highlights that they had planned for which roads the different trucks should use, as well as how many they were allowed to wait outside the gate. During the initiation, they struggled to set the right time for how often a new truck could arrive and what number of trucks that should be waiting, but this was refined until the optimal times for the different events were set.

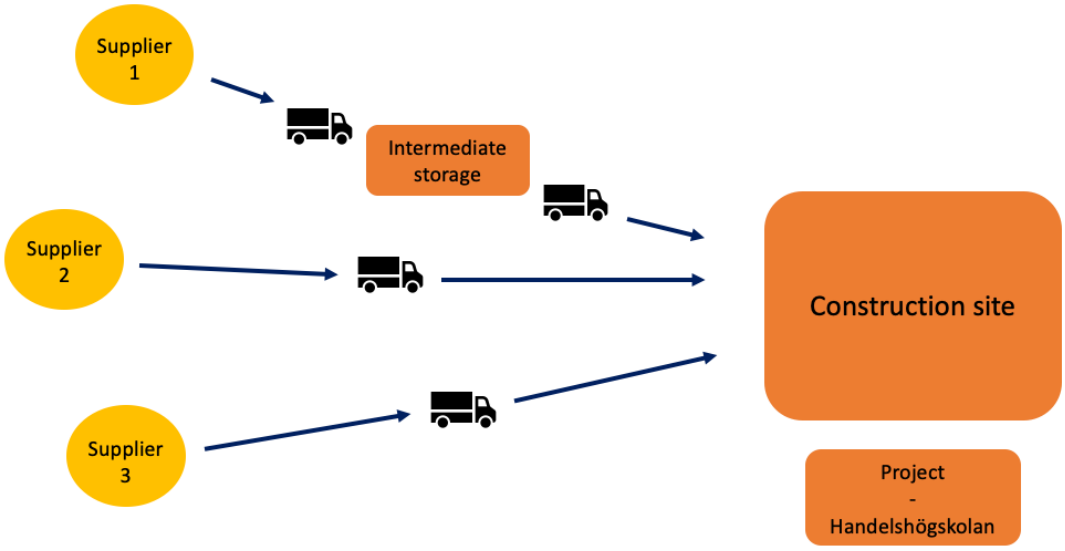

Figure 9: An illustration of the logistic setup at Handelshögskolan

4.3.2 Environmental awareness regarding transports at Handelshögskolan

When discussing the environmental awareness in the project, the *Project Manager* highlights the different hinders that they face in this particular project. Initially, It was explained that the project is governed by the city in terms of when transports in the area are allowed and how much weight every truck could carry. The *Project Manager* stresses that the weight limits on the nearby roads, in conjunction with the heavy nature of the needed material, make it impossible to achieve a high fill rate with regard to volume. Even though this is the case, it was mentioned that they strive to always reach the weight limit and thereby achieve a high utilization rate in terms of weight. In addition to the weight limitation, transports to and from the project were only allowed to drive in certain time slots. The *Project Manager* explains that as a consequence of the different limitations, the transports to the site have increased.

Therefore, to reduce the number of unnecessary transports as much as possible, the *Project Manager* stresses the importance of planning. Good planning and management of transports are beneficial not only from a project performance standpoint, it is also favorable from an environmental perspective. Consequently, the *Project Manager* emphasizes that they actively worked to optimize this process and that a well-planned execution of transports diminishes the waste of unnecessary resources, such as a high number of transports, preventing idling, and a low utilization rate.

According to the *Project Manager*, there exists an awareness within the project regarding the environmental impact from different activities. Rather simple requirements have been taken into consideration, for instance, when trucks are waiting

outside the gate they are not allowed to leave their engine running. During the initiation of the project, almost all lorries who waited, left their engine running, but the *Project Manager* explains that they had come a long way with this work and that improvements have been made. Another active choice made in the project is to have one person responsible for the ordering of all small items in the project. By doing so, the number of transports is actively reduced simply by gathering all small orders into larger delivery, as the *Project Manager* mentions.

4.4 Structuring and managing transports within Serneke

This section presents a description of how transport and logistics are handled today at Serneke. Also, this part will examine how Serneke currently works with suppliers of material and transport services.

4.4.1 Transports as a part of material purchases

According to the *Purchasing Manager*, transport services are rarely procured directly within Serneke. Instead, the focus is on the material that needs to be purchased in order for the projects to proceed, and therefore, the transports are often included in the material cost. Moreover, the *Purchasing Strategist* mentions that it is unusual that any effort is spent separating, or clearly defining, the cost for material and transport. Consequently, the priority is rather that the right material reaches the site, instead of the actual transportation method. This statement is also strengthened by *Site Manager B* who emphasizes that the focus in the project is always on the cost of the material delivered to the site, no time is generally spent on assessing in what way the material is delivered.

On the project level, *Site Manager A* describes that they have a large possibility to decide who to buy material from and who to work with. The *Environmental Health & Safety Coordinator* also highlights that Serneke provides the projects with a lot of freedom in the projects. Still, it is explained that Serneke has a list of preferred suppliers to use, although the projects can choose other suppliers that have not previously been on the preferred list. Regarding which purchasing decisions are taken on a project level, *Site Manager A* states that large purchases in an early stage, even before the project organization is assembled, are often administered by Serneke's central purchasing division. However, *Site Manager A* highlights that to which extent they want to utilize Serneke's central purchasing division later in the project is decided by the project organization.

Furthermore, since the focus is on the material, the *Purchasing Manager* explains that it is often the supplier or wholesaler that sets the requirements for the transport services. In addition, the company that delivers the material is often contracted by the supplier or wholesaler, and therefore Serneke's ability to affect this process is limited. As a consequence, the *Environmental Health & Safety Coordinator* concludes that Serneke is somewhat controlled by the suppliers in this aspect. Due

to the fact that the suppliers are in a position of power regarding transports, the *Purchasing Strategist* emphasizes that in order to drive a change towards environmentally friendly transport options, they are a crucial part. For example, when a supplier or wholesaler claims that they have a well functioning and widespread transport solution it would not be possible, according to the *Purchasing Strategist*, for Serneke to put strict requirements on something that may be a key component of a supplier's business.

4.4.2 The current approach to framework agreements

The *Purchasing Manager* describes that since every specific project has a lot of freedom regarding material purchases, Serneke has a limited number of framework agreements within the company. The *Project Purchaser* and the *Purchasing Strategist* state that historically, Serneke has embraced "a sense of entrepreneurship" within their projects and therefore has had few strategic requirements for the projects to follow. Further, the *Project Purchaser* presents that as a consequence of this, the possibility but also responsibility to affect different aspects related to the environmental impact has varied. The *Environmental Health & Safety Coordinator* also stresses Serneke's history of providing a lot of freedom for the projects and that it could be somewhat difficult to force the projects to act in a certain way.

However, Serneke is trying to formulate some long term agreements with certain suppliers in the form of framework agreements according to the *Purchasing Manager*. This transition has just started but is a step towards long term, collaborative, agreements within the company. As a way to illustrate the importance of more collaborative agreements, the *Purchasing Manager* mentions the mutual benefits. A material supplier earns money from selling a product and the service associated with that product, consequently, they want to be as effective as possible regarding the number of transports that are required. The *Purchasing Manager* explains that because of that, it is advantageous for Serneke as well as the supplier to cooperate and thereby reduce the number of transports if possible.

4.4.3 Logistics management and common methods

When discussing how logistics and transports to different sites are managed, the concept of just in time (JIT) was something that multiple interviewees mentioned. The *Purchasing Manager* describes that JIT is crucial in every type of building production, and furthermore highlighted the importance of fulfilling all the needs related to JIT deliveries for every specific project. Although different projects set different requirements for the deliveries, depending on how crowded the site and surrounding area are, stricter requirements can be needed in some cases.

According to the *Purchasing Manager* delayed deliveries, as well as early deliveries, could cause problems for the progression of a project. Delayed deliveries could jeopardize the planning for the whole project while too early deliveries could affect the quality of the material since it can be damaged if stored outside. As *Site Manager A* stresses, the type of material used in construction is also a reason for the use of

JIT. For instance, delivery of sensitive material needs to arrive exactly at the right time so that it can be placed in the building where it is sheltered from the weather.

An additional method discussed with the interviewees is the use of a construction consolidation center (CCC) and a third party logistics provider (TPL). Today, this method is not commonly used by Serneke and except for the *EPCM Engineer*, none of the other interviewees worked with this method today. According to the *EPCM Engineer*, this approach works well in the project Karlatornet which the *TPL Manager*, responsible for the provided solution, also acknowledges. The fact that Serneke has understood the need for this type of collaboration is vital since a construction project constantly changes and faces different obstacles, according to the *TPL Manager*.

One method that the *Purchasing Manager* mentions that has been tested only in some projects is the use of a delivery container. It has not been fully implemented yet, but the *Purchasing Manager* describes that it is an useful strategy to handle materials in terms of delivery and storage. It can be used like a tunnel, with one door on each side of the container, that all personnel involved in the project have access to. According to the *Purchasing Manager*, this system is an alternative that Serneke is about to develop.

4.5 Issues related to transports and planning

In the interview process, all respondents highlighted the cost aspect as one of the main hinders. For instance, the *Environmental Health & Safety Coordinator* mentions that one issue is that transports are often driven over long distances which causes a lot of emissions. The reason for this is often that price is the only factor that is considered when the material is purchased. Furthermore, *Site Manager A* also describes that the purchasing price for materials is generally a deciding factor that hinders them to choose suppliers in close geographical proximity, which would be preferable from an environmental standpoint.

Even though CCC is considered to be a favorable method from an environmental standpoint, there are several hinders that prevent a broad implementation. As *Site Manager B* notes, this method is most likely very costly, thus, it can be difficult to use the solution on a wide scale. In the same way, the *Project Purchaser* describes that storing material is always expensive, not only since it requires a lot of resources to run the storage facility, but it can also be problematic to tie up capital. Furthermore, *Site Manager A* mentions that in many projects of a smaller size, it is difficult to motivate the additional cost. Likewise, *Site Manager B* adds the perspective of how material and transports are currently purchased, and since materials is often purchased with the delivery included, it is difficult to justify why additional resources should be spent on a consolidation solution. Lastly, the fact that the potential savings from this type of solution are very hard to quantify is a major obstacle according to *Site Manager B*.

4.5.1 Lack of control over the transport process

Regarding transports, the *Purchasing Manager* describes the current situation where many vehicles are driven with a low fill rate as a major environmental issue. In addition to the low fill rate, the *Project Purchaser* explains that it is a potential issue if the material is offloaded and then reloaded together with other material. Consequently, this can cause longer offload times on the site since the material is not organized in the truck, potentially causing delays. Also, the *EPCM Engineer* addresses that lack of planning is a crucial aspect that needs to be taken into consideration. If there is not sufficient planning in place, a situation where some required material is forgotten might occur, material that needs to be ordered quickly to not face interruptions in the production. In turn, this causes rushed deliveries that often are driven solely to the site with a very small quantity of material, causing unnecessary transports and emissions according to the *EPCM Engineer*.

The *Purchasing Manager* mentions another issue connected to transports which is the lack of direct coordination and communication with the transport companies. Since materials is often purchased together with the deliveries, Serneke has limited ability to interact and affect the way the transport is carried out. The *Purchasing Manager* emphasizes that this is a complex chain with many actors included, for example, a supplier may have procured a transport company but this company could have contracted additional transport companies for some of its deliveries. This is problematic and a hinder for Serneke since they don't have the possibility to control all parts involved.

4.6 Climate declaration

When discussing the new climate declaration act with the interviewees, which is described in detail in section 2.2, only those who actively work with environmental related issues as a part of their profession were familiar with the new requirements. The roles included were: The *Quality & Environmental Strategist*, *HSEQ Manager*, *Environmental Health & Safety Coordinator*, and the *Chief Sustainability Officer*. However, the *Quality & Environmental Strategist* highlights that since the act is very new and that the industry has not decided on a uniform way to work, Serneke has not yet educated all affected personnel. When discussing why the industry has been slow in adapting to the new requirements, the *HSEQ Manager* mentions that the Swedish National Board of Housing, Building and Planning has been slow in presenting the necessary tools. This has caused companies to hold off their work regarding tools and routines until it is clearly stated how the new requirement will be implemented in practice. Nevertheless, Serneke has created a general guide, illustrating how a climate declaration should be developed within the company. In addition, there are plans for that everyone that will come across and work with climate declarations, should be provided with the necessary education.

In the initial phase, Serneke aims to use the generic values provided by the Swedish National Board of Housing, Building and Planning according to the *Quality & En-*

vironmental Strategist. This is done since it is considered to be too complicated to demand the data required for actual calculations in this early stage, even though this is the long term objective. As the *HSEQ Manager* describes, the Swedish National Board of Housing, Building and Planning clearly states that the generic values are set at a high level in order to favor actual calculations. In the same way, the *HSEQ Manager* highlights the possibilities of achieving advantages in the industry if Serneke became good at calculating their emissions. In future projects, a scenario where the client sets certain demands concerning the climate score for a building may occur, hence causing it to be necessary to be specialized in calculating emissions and producing accurate climate declarations.

When discussing the process of doing actual calculations the *Quality & Environmental Strategist* mentions that one obstacle is deciding how the needed data should be collected. Following this, the *Environmental Health Safety Coordinator* emphasizes that much of the data needed to perform the climate declarations already exists but it is not easily available. For example, new machinery logs journeys and provides information such as distance driven and fuel consumption, but there is no uniform way in place to compile all data. In addition to logging the data, both the *Project Purchaser* and the *Purchasing Strategist* explain that it is important for Serneke to have a well-developed dialog with their suppliers. In order to collect data that is usable, Serneke must set certain demands on their suppliers regarding what information connected to the transports they should be able to share. According to *Site Manager A* it is relatively easy to collect all data in an excel sheet, but as the *Environmental Health & Safety Coordinator* highlights, it is not sufficient that all different projects do this in their own way, Serneke needs a standardized approach for this to be feasible. The *EPCM Engineer* describes that one way that this can be done, is through a proper cloud based logistics management system in which all deliveries are logged, such as the one used at Karlatornet. In this system, a lot of information is available regarding transports, but since there is no demand for the project to collect the information, this possibility is not utilized according to the *EPCM Engineer*.

Regarding the actual environmental benefit achieved by the requirement for climate declarations, the *HSEQ Manager* emphasizes that it is a step in the right direction. According to the *HSEQ Manager*, the demand will force Serneke to start and assess their choice of, for example, material at an early stage in the construction process. The *Environmental Health & Safety Coordinator* also describes that this new requirement will improve Serneke's knowledge regarding their current environmental performance. For instance, it is highlighted that by calculating all emissions it enables smart choices of solutions that are more environmentally friendly. The *Purchasing Manager* mentions that another aspect is the awareness and understanding of a building´s climate impact will increase, if a building and its production is provided with a score, it becomes easier to see the benefits of different choices.

One thing that the *Purchasing Manager* notes is the potential problem that the demand for climate declarations will exert on smaller actors within the industry. While it could be an advantage for larger companies with well-developed support

functions within the company, it could hamper smaller ones that don't have any specialized personnel in-house. In the future, specific roles that work specifically with the development of climate declarations might be required to meet future demands according to the *Purchasing Manager*. An additional consideration that the *HSEQ Manager* presents is that the climate declaration is something that is produced after the building is completed. In order to affect a building's climate score, different decisions need to be taken early in the process and the climate declaration will only illustrate if one has achieved a particular score or not. Therefore, to reduce the climate impact from a building it is not enough to be good at producing climate declarations. Serneke also needs to develop their understanding regarding the choices that are made in an early stage in the project process according to the *HSEQ Manager*.

4.7 Identified tools for a reduced climate impact

In this section, different approaches that the interviewees mentioned as future possibilities to implement in order to reduce the climate impact from transports are presented.

4.7.1 Planning and collaboration

One aspect that was discussed frequently during the interviews is the need for better planning and collaboration. As the *Environmental Health & Safety Coordinator* describes, more strict requirements within the sector will force others as well as Serneke to plan their transports better. Furthermore, it is mentioned that it would be advantageous if all municipalities would develop joint requirements for the whole of Sweden in order for transport providers to be able to create a functional way of working. Everyone needs to be working towards the same goals and it is important to make everyone base their work on the same requirements according to the *Environmental Health & Safety Coordinator*. Also, since the focus on environmental issues within the construction industry have been generally low, it is now difficult to get everyone onboard and invest in new solutions. In order to make it possible, it is therefore crucial that certain demands are put on the whole industry as the *Environmental Health & Safety Coordinator* describes.

From an environmental perspective, the *Project Manager* believes that planning could have a major impact on how well a project performs. Many essential decisions are made during the design phase and therefore it is crucial to start to think about how transports should be managed already in the early stages. Therefore, by striving for higher competence in the design phase where prerequisites are set for a project, better environmental awareness and performance could be reached.

An additional aspect to keep in mind is, according to the *Environmental Health & Safety Coordinator*, the fact that the client is often the one who sets the requirement for a project. Consequently, the clients need to be interested in and want to achieve a change towards a reduction of the climate impact in the construction

industry. One way forward for this according to *Site Manager A*, is that Serneke can present different environmentally friendly options during the procurement stage so that clients know what possibilities exist in the project. *Site Manager A* explains that if the clients were informed that if they were to spend a little more money on a project, the environmental footprint would decrease with a certain amount, it is much more likely that they would be interested in doing so.

4.7.2 Construction consolidation center

Another solution mentioned during the interviews was the use of a specialized logistics provider and a consolidation center. This is an approach that is used in Karlatornet and according to the *EPCM Engineer* this working method is beneficial from an environmental standpoint. In order to have a smooth operation on the site, they want to receive full truckloads, and by storing material in an off site location for 4 days, they can consolidate the deliveries to the project site. When visiting the project at Litteraturgatan, *Site Manager A* was asked whether a consolidation center would be beneficial for this project. *Site Manager A* describes that this type of solution both causes higher costs as well as a more complex logistic setup, and therefore, it is argued to not be useful in this project. However, when discussing deliveries of sensitive material, *Site Manager A* stresses that the suppliers generally have a hard time adapting their production and they need to deliver their material on the set date. If the project is not able to store the material in the building, some sort of buffer is needed, a situation where an intermediate storage solution might be an appropriate solution.

Site Manager B believes that a consolidation center could be a very favorable solution from an environmental standpoint if done right. This type of solution makes it possible to run full truckloads to the site at the same time as it enables more control over the type of vehicles that are used for the transportation between the CCC and the site. Furthermore, the *Project Manager* describes the use of a CCC as something beneficial from an environmental perspective, not only for a single project but if implemented on a larger scale, for all Serneke's projects. It was believed that a terminal could be set up in a strategic location and thereby serve multiple projects. In this way, the cost of running the terminal could be shared among multiple projects according to the *Project Manager*.

Site Manager B emphasizes that when applying this type of solution if aiming for a low environmental impact, there are a lot of additional considerations to make. Aspects such as the type of trucks that are used at the terminal and if they are driven on fossil fuels or electricity, or how the facility is heated are highly important to have in mind. Also, by ordering full truckloads to a storage facility, and then consolidating the material with various materials for the project, the number of transports will be reduced compared to deliveries from every supplier in smaller batches directly to the site. According to *Site Manager B*, a project will be more resistant to delays caused by a lack of material if it is stored at a nearby location.

The *HSEQ Manager* agrees that a consolidation terminal is an effective way to

reduce the number of trucks that have to be driven to the project site and thus it is favorable from an environmental standpoint. In addition to lowering the emissions due to a lower number of trucks, it also makes it easier for the project to manage. The *Quality & Environmental strategist* also mention that a storage facility could be beneficial from an environmental standpoint, both by reducing the number of deliveries but also because it enables increased control of the deliveries between the terminal and the site.

4.7.3 Long term agreements and collaborative contracts

Two other aspects that were frequently mentioned during the interviews were different collaboration forms and long term agreements with suppliers. As the *Environmental Health & Safety Coordinator* describes, Serneke has a long tradition of letting the project have the power over which suppliers to use. If Serneke would continue on this path with low central interference and a lot of decision power in the project, all personnel in each project needs to be very skilled regarding the environmental aspects. The *Environmental Health & Safety Coordinator* instead highlights the benefits of long term agreements, which should be mandatory for the projects. In this way, long term contracts could be developed, in which a greater focus could be spent on optimizing the delivery process in order to reduce its environmental impact. Even if the idea of long term agreements with suppliers contradicts Serneke's historical way of working, the *Project Purchaser* states that it would be beneficial in the long run from an environmental perspective.

The *Purchasing Manager* also notes that by formulating long term contracts with suppliers it will be possible to attain better collaboration where one output could be that the number of transports will be reduced, which is advantageous for both parties. Another benefit of long term agreements that the *Project Manager* mentions is that it could provide incentive and security for the transporter where they will be able to make investments in vehicles that are more environmentally friendly. *Site Manager B* also stresses the use of long term agreements and explains that if Serneke uses this type of agreements, it will foster better collaboration with suppliers, enabling smart choices which in turn could reduce the environmental impact. This collaboration creates a sense of a "preferred customer" and "preferred supplier" relationship in which both parties feel prioritized according to *Site Manager A*.

Regarding the type of contract within the project, different collaboration approaches, such as Partnering, are described as preferable in many ways according to the *Environmental Health & Safety Coordinator* and the *Project Manager*. One specific advantage that the *Project Manager* mentions is that it makes people challenge the usual way of working. People strive for improvements and when a close collaboration between the actors within the project is initiated, it is often easier to make things happen. When implementing partnering, for example, the contract is developed in a mutually beneficial approach. Both the *Project Purchaser* and the *Purchasing Strategist* believe that by adopting partnering, the focus can be shifted from a "us" versus "them" towards a "we" mindset between everyone in the project. However, the *Environmental Health & Safety Coordinator* mentions that even if partnering is

favorable since the contracts are developed in a more collaborative way, it is crucial to have a close continuous discussion between the actors, otherwise it is impossible to make it function as intended. An additional consideration that the *HSEQ Manager* states is the longevity of the contracts. Construction activities are constantly progressing and because of that, the prerequisites also evolve and therefore it is important to have the possibility to update and change the contract during the process. This is vital in order to continue making progress regarding lowering the environmental impact.

The *Purchasing Strategist* further argues that if a client lacks experience in working with issues related to the environmental impact from transports, a partnering collaboration can be very beneficial from an environmental standpoint. In the case where the client has not formulated any particular demands in the procurement stage, Serneke can together with the client, in a partnering setup, discuss different options regarding, for example, the choice of material and how it should be delivered in order to reduce the climate impact. In the same way, the *Purchasing Manager* highlights that Serneke as a contractor is very limited to what the client demands and wants to pay for, and consequently a partnering collaboration enables Serneke to provide different options and solutions for the client.

4.8 An external view on transport planning

The *Energy & Climate Coordinator* highlights that a general solution that can be applied to reduce the number of transports is better planning and longer delivery windows. Furthermore, it is noted that this is difficult within the construction industry since material often can be stored on the site, and therefore, JIT deliveries are often preferred from a productivity standpoint. According to the *Energy & Climate Coordinator*, this is problematic from an environmental standpoint, it is mentioned that JIT deliveries are most certainly not preferable from an environmental point of view. To cope with this, the use of buffer storage such as consolidation centers are highlighted as a useful solution. The *Energy & Climate Coordinator* explains that by using a consolidation center, transports can be given a time slot that is more flexible which reduces the need for rushed deliveries.

Moreover, another aspect that the *Energy & Climate Coordinator* presents is the need for long term agreements between the transport providers and the ones that are buying the transports. It is mentioned that within the construction industry, companies often work together for long periods of time, upwards of 10-15 years. Still, the contracts between them often extend for much shorter periods. If the contracts span over longer periods of time, the *Energy & Climate Coordinator* emphasizes that it will make it possible for transport providers to invest in vehicles and equipment that are favorable from an environmental perspective. Regarding responsibility for driving this change, the *Energy & Climate Coordinator* believes that the material purchasers have as much responsibility as the one who performs the transports. Further, it is also stressed by *Energy & Climate Coordinator* that companies that have a large influence within the industry need to take responsibility and actively

participate in achieving change in order for it to happen.

Regarding the cost aspect, which is often brought up as an obstacle when trying to implement environmentally friendly options, the *Energy & Climate Coordinator* points out that this way of thinking is very short sighted. Accordingly, it is highlighted that it is essential to foster other values except for the price. If presenting a product or service to a customer, the customer's interpretation of the item is vital. The *Energy & Climate Coordinator* explains that to make customers choose something that is more expensive they must feel that they get something else of value in return, for instance, a product with a much lower environmental impact. In that way, the focus could shift towards the total value of a product or service, not the actual price. While the immediate cost may be higher, the costs of not acknowledging the importance of choosing environmentally friendly solutions will be significantly greater. As an example of this, the *Energy & Climate Coordinator* mentions the reduction duty that exists in Sweden. While the direct cost of fuel is more expensive, the increased percentage of renewable content in the fuel reduces the climate impact as well as foster the production of renewable diesel, hence this is a very efficient method.

4.9 Sernekes vision regarding sustainability

During the last few years Serneke has made some major improvements regarding their sustainability work according to the *Chief Sustainability Officer*. By evaluating the sector and assessing how to continue to stay competitive, as well as cope with the evolving construction industry, they have identified the need for a specialized sustainability function within the company. To continue forward, it is mentioned that it is important for Serneke to decide what role they want to play in the development towards a more environmentally friendly industry.

The *Chief Sustainability Officer* further believes that one of the key factors for succeeding with the sustainability work is to develop specific intermediate goals, with the intention of illustrating the progression regarding the reduction of the environmental impact. In this way, it will increase the understanding of the issues within the company and also clearly define what benefits different actions can have. As the *Chief Sustainability Officer* mentions, it is crucial that these goals are easy to measure and grasp. It is emphasized that it is important to not only set the goals but also to develop a roadmap for how they should be reached. Similar to the goals, this roadmap also needs to be created in a way that makes it accessible and understandable for people in various positions within Serneke. However, the *Chief Sustainability Officer* states that none of these goals are useful or valuable if they are not followed up during the process.

When discussing the potential problems with a decentralized organization the *Chief Sustainability Officer* highlights leadership as an essential factor. For instance, it can be the case that the project organization does not always align with the strategic views within the company. In this situation, it is important to have good leaders

that could increase the knowledge throughout the whole organization and thereby bridge the gap between all functions and divisions within Serneke. In relation to this, the *HSEQ Manager* emphasizes that Serneke needs to leave the stage of creating good looking strategic visions and move towards actual implementation.

The *Chief Sustainability Officer* describes that in terms of future possibilities, the new demand for climate declarations is a positive incentive. It not only serves as a way to present a building's climate impact during the construction, it also increases the awareness and understanding concerning what climate impact different methods and materials actually cause. Still, the *Chief Sustainability Officer* advocates even tougher requirements on the industry in order to reach the goals set by the Swedish parliament.

Money is still the decisive instrument and therefore the *Chief Sustainability Officer* believes that additional demands, except from declaring the emissions from the production of a building, are required. For example, the *Chief Sustainability Officer* mentions setting a price on emissions, with the possible effect of making it expensive to not acknowledge the environmental aspect. In this way, people would realize the importance of considering this, otherwise, it will potentially result in a huge cost. In relation to transports, the *Chief Sustainability Officer* agrees this is also an area that needs attention. One way of doing this could be for Serneke to be able to present alternatives for the client in the process of buying material and its transportation. If Serneke presents different options in terms of what supplier to choose, the client has the opportunity to not only base their choices on cost, but also on how environmentally friendly their options are.

5 | Discussion

The discussion makes use of the theory to scrutinize the empirical findings. The different sections in this chapter have their point of departure in the research questions. First, section 5.1 highlights the identified hinders regarding construction transports. Thereafter, based on the previously identified hinders, various solutions are investigated in section 5.2. In the final section, 5.3, it is examined how Serneke could act in order to strengthen their position regarding sustainable transports within the construction industry.

5.1 The main challenges from transports for Serneke including the perspective of environmental impact

In this section the recognized hinders have been gathered and elaborated on. Different themes have been developed in order to facilitate and structure the discussion.

Transport included in material purchase price
The importance of a functioning material flow is considered a key issue for Serneke, not the least as half a project's total cost is made up of material which makes it important for the project's success, as also previous studies confirm (Ying et al., 2018). Sezer and Fredriksson (2021a) argue that the transport services which bring the material to the site should be equally important as the material, but the results from the study indicate that transports tend to be forsaken, thus, the impacts of transport services per se are somehow not prioritized, besides the fact that materials need to arrive to the site. In line with this, *Site Manager A* stresses that the material price is the most essential factor when purchasing materials and *Site Manager B* indicates that the general focus is on the materials themselves, and the material transport tends to be neglected.

Furthermore, Ying et al. (2018) identify that materials are commonly purchased "as delivered" which also holds true for Serneke; they do not distinguish the transport from the material cost, as the *Purchasing Strategist* and *Site Manager B* present. The objective is rather to secure material for the projects, a claim that the *Purchasing Strategist* agrees with. This implies that it is difficult to distinguish the transport cost part in the material purchase. Consequently, environmental impact

from construction transport is problematic as there is a lack of transport information, including transport costs. The analysis thus shows that transports need to be acknowledged as an own process including prerequisites and outcomes of various ways of transport organization.

The cost focus
Following the focus on the purchasing cost, it is not possible for Serneke to set environmental criterias above cost if the public client does not set requirements on certain climate aspects. In accordance with the perception of *Site Manager A*, the strict cost focus within the law for public procurement is identified as an obstacle. However, in Sweden today, there is a strict regulation in place controlling what type of prerequisites the client can set in order for everyone that is interested to be able to submit a tender according to the Public Procurement Act (Konkurrensverket, 2021). As illustrated in project Litteraturgatan, which is tendered through a public procurement process, materials were chosen solely on price which caused unnecessary long transport routes, consequently posing an example of the environmental issues of being governed by the current regulation.

In order to promote change, the client has to be able to set demands in the procurement process regarding environmental factors, demands that contractors who submit tenders have to obey, which the *Energy & Climate Coordinator* also addresses the need for. Since the objective of every business is to generate profit in all aspects, price should not be the only deciding factor. The transition away from the hinder of this strong price focus could be assisted through laws and regulations where the environmental impacts are emphasized. In this way, the "playfield" would be more evenly and everyone would be forced to actively search for more environmentally friendly options, for instance, using suppliers in close geographical proximity.

Project independence
The fragmented nature of the construction industry is also reflected in the way Serneke currently works. The emphasis on each project as its own entity hampers strong performance and uniformity within the whole company, as also Vrijehof and Kosekela (2000) affirm. The construction supply chain is very dependent on the circumstances in the specific project as Behera et al. (2015) mention. Serneke is not an exception in relation to these characteristics, since there is a strong sense of entrepreneurship within the company. In this way, all the projects are provided with a high level of freedom which hinders when trying to achieve a more environmentally friendly transport process, a concern that the *Environmental Health & Safety Coordinator* shares. If Serneke continues on the path where large autonomy is designated to each project, it will affect the project organization in several ways. For instance, this study indicates that the knowledge and competence within each project must be higher or that the independence of the projects should decrease. This is to develop and understand the importance of environmental awareness connected to transports of material and to closer link the projects together.

Inefficient deliveries
In order to achieve a construction production process the concept of Just In Time

(JIT) is identified as one of the most requested approaches. However, as the purpose of JIT is to deliver material when it is needed, following Sullivan et al. (2010) description, it can create a problem regarding an increased environmental impact caused by the high number of vehicles with a low utilization rate. Moreover, the reasoning that JIT is not beneficial from an environmental standpoint is in line with the opinion of the *Energy & Climate Coordinator* who claims that JIT can encourage unnecessary transports when serving only a single project.

Following this, the inefficient utilization of vehicles is identified as a hinder when striving for a reduced environmental impact, which the *Purchasing Manager* strengthens by claiming that one of the main environmental issues regarding transport is that the fill rate is too low in the deliveries. In the same way, the *Project Purchaser* mentions that reloading of material is another issue that causes longer off load times. Therefore, it could be questioned whether transports with a low fill rate are unnecessarily executed due to the fact that JIT is always desired. The study identifies that there is a fine balance between striving for the lowest possible number of vehicles with a high utilization rate and delivering a suitable amount of material to the site which often lacks storage possibilities. Still, constructing buildings is different from other types of production and requires certain considerations, and acknowledging JIT as a solution with a potentially higher environmental impact should not be neglected.

In addition to the use of JIT, there could exist additional hinders behind the low utilization rate of the deliveries, for instance, it could be one direct effect of a lack of coordination. This understanding is reinforced by theory, Dubois et al. (2019) explain that uncoordinated spot purchases are often driven directly to the site, deliveries that frequently include only smaller packages or single pallets. The lack of coordination between the supply process and the construction process increases the difficulty to achieve a high level of collaboration between actors involved in each process. From Serneke's perspective, this issue is evident when they describe a lack of control over the transport process where they have a hard time controlling the whole supply chain, including transports. Therefore, an increased level of coordination and collaboration is vital when trying to induce change towards more environmentally friendly transports, as the *Purchasing Manager* highlights. Potentially, this could entail a situation where the usage of the vehicles are optimized with regards to utilization rate.

The ambiguity of responsibility

Furthermore, a common understanding identified in the study is the perception that it is the suppliers of material that are responsible, and should set demands on the transport providers. This is since the suppliers of material are often the one who has the agreement with the haulier. Still, it is equally important that the material purchaser understands the importance of setting the right demands in order to make environmental improvements, which the County Administrative Board states in their guideline for transports. Therefore it is essential that the material purchaser understands the importance of setting the right demands in order to make environmental improvements. With this in mind, the study indicates that

there is a lack of knowledge on how to manage and coordinate transport services with an environmental focus, as well as a lack of awareness concerning Serneke's responsibility to set environmental requirements on transports.

With the purpose of raising awareness and setting criteria for how climate data should be gathered and presented, one step towards acknowledging the environmental impact from a building is through the new law for climate declaration as the Swedish National Board of Housing, Building and Planning promotes. Furthermore, The Swedish National Board of Housing, Building and Planning claims that one reason for the regulation is that they have identified a request from the industry regarding stricter laws and requirements. The empirical findings indicate that even if several interviewees were positive towards stricter laws and regulations, there are mixed understandings of what positive impacts the climate declarations can provide.

There is still an uncertainty about how these climate declarations should be developed and consequently who carries the ultimate responsibility to collect the required data. In Serneke's perspective, it is deemed too complicated to perform actual calculations at this early stage and this is the reason why instead Serneke uses generic data, as the *Quality & Environmental Strategist* explains. However, the study confirms that on many occasions, a lot of data regarding transport is already available through different types of software and the only thing that is missing is a decision for gathering and using this data which the *EPCM Engineer* explains. Hence, the mindset of interpreting it as too complicated to perform actual calculations as well as not seeing any benefits of carrying out these calculations could pose a hinder for Serneke.

Summary of challenges
In Figure 10, a summary of the identified hinders is illustrated. These hinders will be presented together with possible solutions and their effects in the next section.

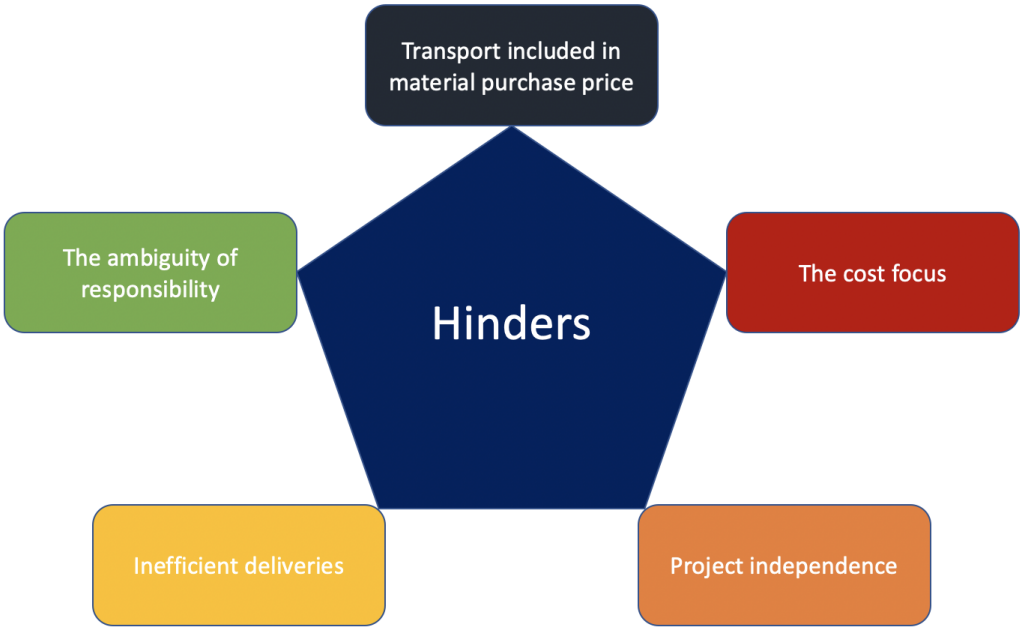

Figure 10: The identified hinders for Serneke related to construction transports

5.2 Possible solutions and effects for Serneke connected to the identified hinders

A multitude of different solutions exist that could assist Serneke in solving many of the hinders regarding the environmental impact from transports. The majority of the interviewees were also positive towards implementing new initiatives. A full control over all transports would imply that Serneke could achieve the lowest possible environmental impact and maximize the efficiency. Still, this is not possible today, and this transition needs to be made in several incremental steps.

Request transport specification
The process of procuring and creating a contract creates the basis for collaboration, as well as for the demands that can be introduced, as the theory implies (Ruparathna & Hewage, 2015). The current approach to supply material to a site is by purchasing the material with the delivery included. Therefore, if the supplier is the one that has the agreement with the haulier, Serneke's ability to affect is limited as the *Purchasing Manager* argues. Hence, the ability for Serneke to take control of this process is difficult without changing the whole understanding regarding material purchases. This is challenging due to many reasons, for instance, the transport process can be a central part of a supplier's business which makes it somehow sensitive to try to change the way they are performing their business which the *Purchasing Strategist* also acknowledges. Consequently, the change towards a more controlled process needs to be conducted in collaboration with suppliers and hauliers and made one

step at a time.

As mentioned above, the transition towards better control of the delivery process needs to be done in incremental steps. This would imply that for Serneke it is important to start requesting that the transport is not bundled together with the material purchase. This is crucial in the process of beginning to set requirements on how the transports should be carried out. If the transports are not separated from the material it is difficult for Serneke to question how a specific supplier and haulier deliver their material and set demands regarding the environmental impact from transports, which the *Environmental Health & Safety Coordinator* also confirms. Only when Serneke understands and has enough knowledge about their transports to the projects, can they start and set requirements for how they should be managed. However, this could be complicated, due to the fact that actors tend to prioritize and do what is best for themselves (Dubois et al., 2019). In order to overcome this self-centered mindset, Serneke has to work closely with their suppliers in a collaborative way that would benefit all parties involved. Consequently, by striving towards a clearer specification of the actual transport within a material purchase, the transport is easier to acknowledge as a process of its own.

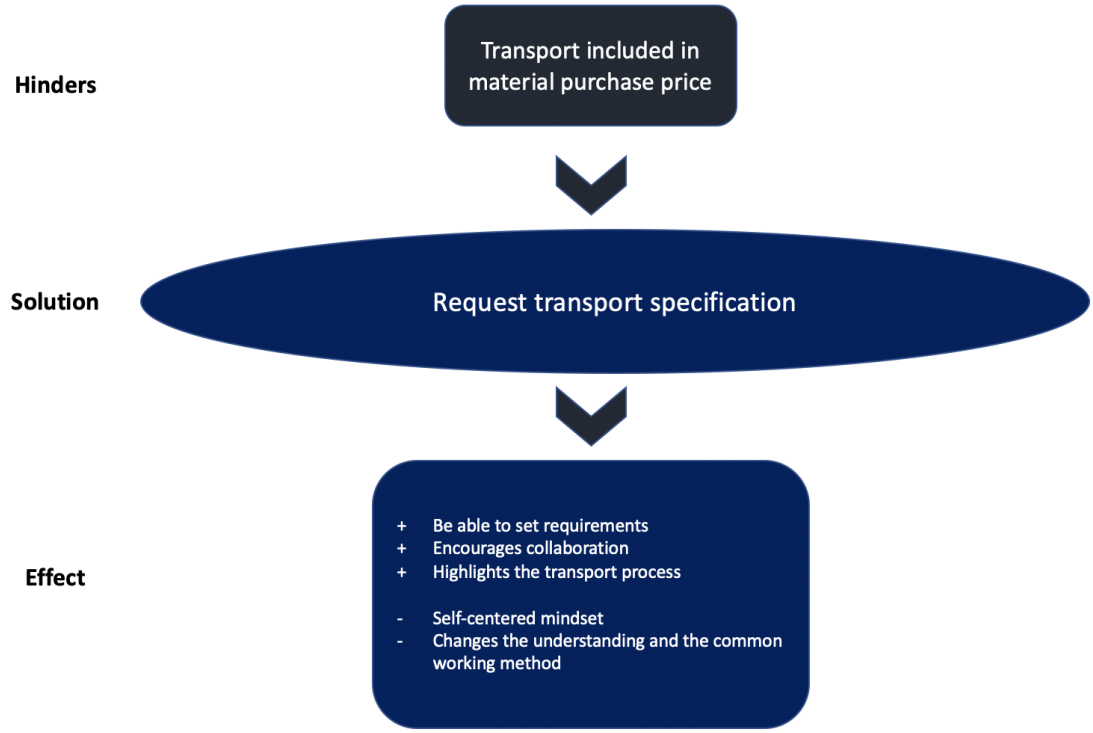

Figure 11: Solved hinders and effects of implementing the solution "Request transport specification"

Make use of a construction consolidation center

For the construction industry, the use of a construction consolidation center (CCC) can be beneficial from an environmental standpoint, as previous research shows

(Guerlain et al., 2019). In the same way, this is also true for Serneke's projects since a CCC can lower the number of transports that have to be driven directly to the site. Therefore, a solution for Serneke is to increase the use of CCC and as a result reduce the environmental impact from construction transports, an understanding that the *Quality & Environmental strategist* and the *HSEQ Manager* share.

A setup with a CCC enables Serneke to control the transports between the center and the actual construction site since all suppliers are not required to be included in this process, as illustrated in Figure 11 below. It allows Serneke to order larger quantities of material to the CCC and consequently reduces the dependence on how the supplier chooses to transport the material to the site. If the material is stored at the CCC, it can be consolidated and delivered to the site exactly when it's needed, hence an actual JIT, with vehicles and transport methods that Serneke has the ability to choose. Thus, it can be stated that a CCC sets the boundary for responsibility between Serneke and their suppliers. However, this does not mean that the collaboration with suppliers should be less prioritized, it is still vital to take care of and focus on strong relationships. Here, Serneke has the ability to procure a specific haulier for the transport from the center to the site, which can be exemplified in the project Karlatornet. As a consequence, the use of a CCC creates the possibility to set stricter requirements, for example, what type of vehicles that should be used, as *Site Manager B* highlights. The increased control and knowledge of the material delivery process could also facilitate the gathering of transport data. This is manageable when using a CCC together with a well-developed logistics software the *EPCM Engineer* claims.

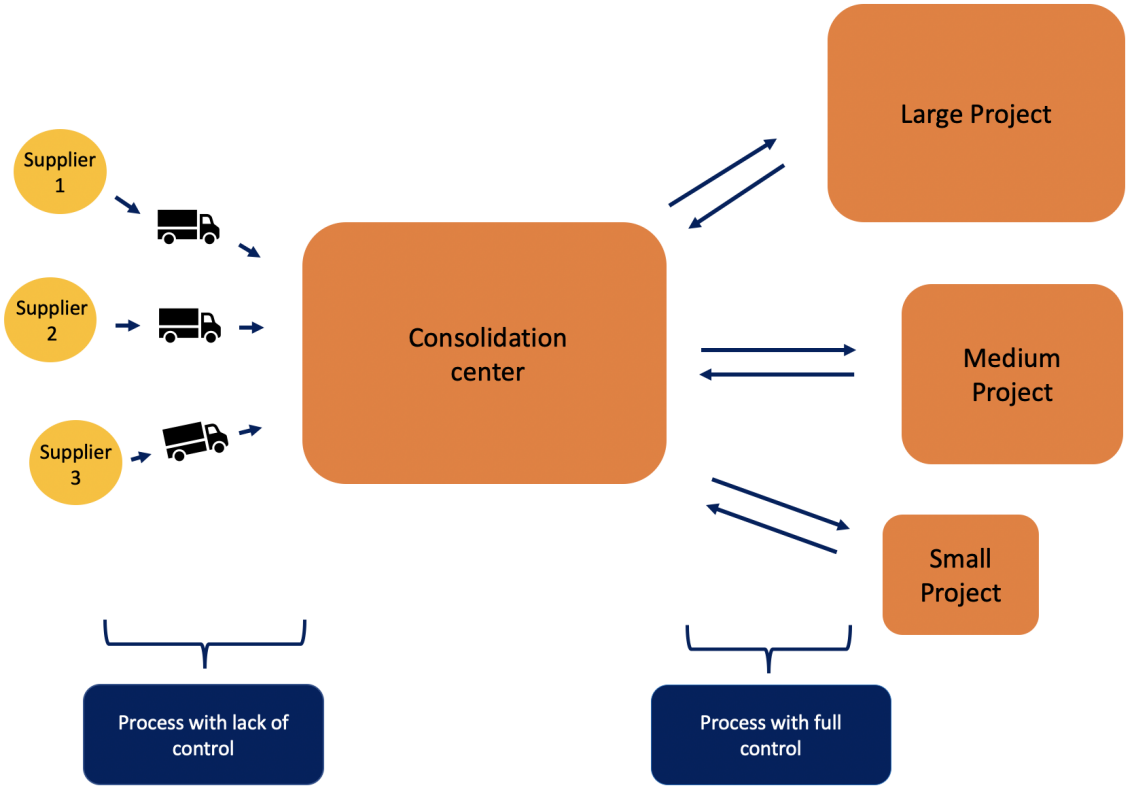

Figure 12: An illustration of the material flow using a CCC in different projects

In order to utilize a CCC in the best way possible, it could be set up in a strategic location, thus serving several of Serneke's projects within a specified geographical area as the *Project Manager* strengthens. In this way, the cost for the terminal can be shared between all projects, lowering the cost for one single project. The resources needed to run a CCC are demanding, and not possible for a single project of smaller size, although it is identified that smaller projects can utilize a center used by multiple projects. *Site Manager A* shares this understanding and explains that in the project of Litteraturgatan, a CCC dedicated to only this specific project can not be justified, even though the project can benefit from utilizing a shared storage facility on some occasions. Likewise, the *Project Manager* believes that a CCC is a useful setup for Handelshögskolan as well, which is a medium sized project.

For Serneke a possible way toward testing this type of solution on a wider scale is to utilize the CCC that is already active for the large project Karlatornet in all Serneke´s projects within Karlastaden. Thus, the existing center could be used in several ongoing projects and serve as a way to evaluate the functionality and possible improvements with this type of solution. However, the study identifies that if Serneke pursues this approach as a solution for multiple projects, a decision has to be made whether to develop the required competence in house or utilize a TPL provider for the logistics management. Consequently, if striving for a CCC solution it is crucial to acknowledge the competence needed to run the facility and manage the whole process. Since construction projects are often very different, as Fredriksson

et al. (2021) argue, it therefore requires a high competence when selecting and implementing various logistics solutions for different types of projects due to factors of project size, location complexity etc.

Considering the above mentioned, it is critical to highlight the importance of not portraying CCC as a cost saving solution since the cost for logistics management will increase (Janné & Fredriksson 2019). This increased cost creates uncertainty, which is evident when assessing the gathered empirical data. As an example, the *Project Purchaser*, as well as the *Purchasing Strategist*, question whether a CCC is economically justifiable. Adding the expense of a logistic solution tends to only be seen as an extra cost, an understanding that Ying et al. (2018) emphasize as a reason for this mindset. To overcome this, it is essential to illuminate the possible outcomes of a CCC, that in the long term perspective could have a positive impact on the total economy of a project.

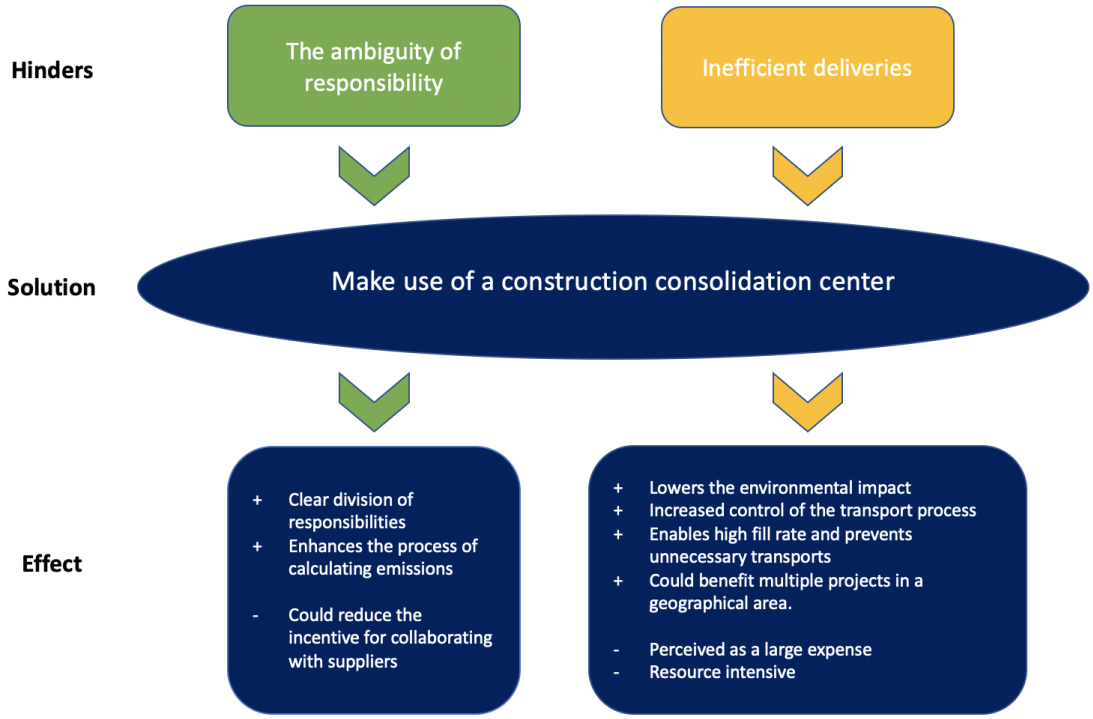

Figure 13: Solved hinders and effects of implementing the solution " Make use of a construction consolidation center"

Apply long term agreements

In a long term perspective it is vital to examine what type of contracts and agreements Serneke enters into with clients, suppliers, and other actors. In order to change and actively work towards understanding that transports should be seen as an activity of its own, long term agreements and collaborations could be a key factor. Long term contracts, with a greater focus on transports could provide incentives for a reduced climate impact which the *Environmental Health & Safety Coordinator* also argues for. Likewise, Badi and Murtaght (2019) claim that long term agreements

enable more strategic work towards a reduced climate impact. Long term contracts will limit the possibility for the individual projects to make their own decisions, which today is a central part of Serneke's way of operating, an understanding that the *Environmental Health & Safety Coordinator* shares. Still, by working together with actors who have a strong focus on reducing the environmental impact from their processes, Serneke can achieve uniformity among their projects and a common way forward for the whole company. Moreover, there is a need for long term agreements to be mandatory within the projects to achieve the mentioned benefits which the *Environmental Health & Safety Coordinator* expresses. The implementation of long term agreements could for that reason increase Serneke's ability to affect the delivery process and foster better planning and collaboration with their suppliers. It also creates an opportunity to be specific regarding how far the responsibility extends for every actor bound by the contract.

Furthermore, long term agreements could also assist in reducing the fragmentation and assist in developing functioning information sharing. Improving these aspects is also important considering that low involvement and lack of knowledge exchange as factors that excel poor execution, as a study by Dubois et al. (2019) show. The *Purchasing Manager* describes that not only Serneke could benefit from these obligatory long agreements. The whole delivery chain could be improved which makes it advantageous for Serneke's suppliers as well, since it increases the total performance of the whole delivery process. Although this is the case, it is important that the formulation of the contract allows for mutually agreed adjustments to prevent a sense of being "trapped" within the agreement.

From another point of view, a close collaboration between Serneke and their business partners, which includes contracts that span over longer periods of time increases the possibility to make sustainable investments, as point to by the *Energy & Climate Coordinator*. Further, AB Volvo (2020) claims that their electric offering of large trucks will increase rapidly in the following years. Therefore, if hauliers would have larger economic security in terms of long contracts it is more likely that they would invest in a more environmentally friendly fleet of vehicles. Following this, the *Project Manager* and *Site Manager B* share the same perceptions and emphasize that a long term contract agreement would foster change.

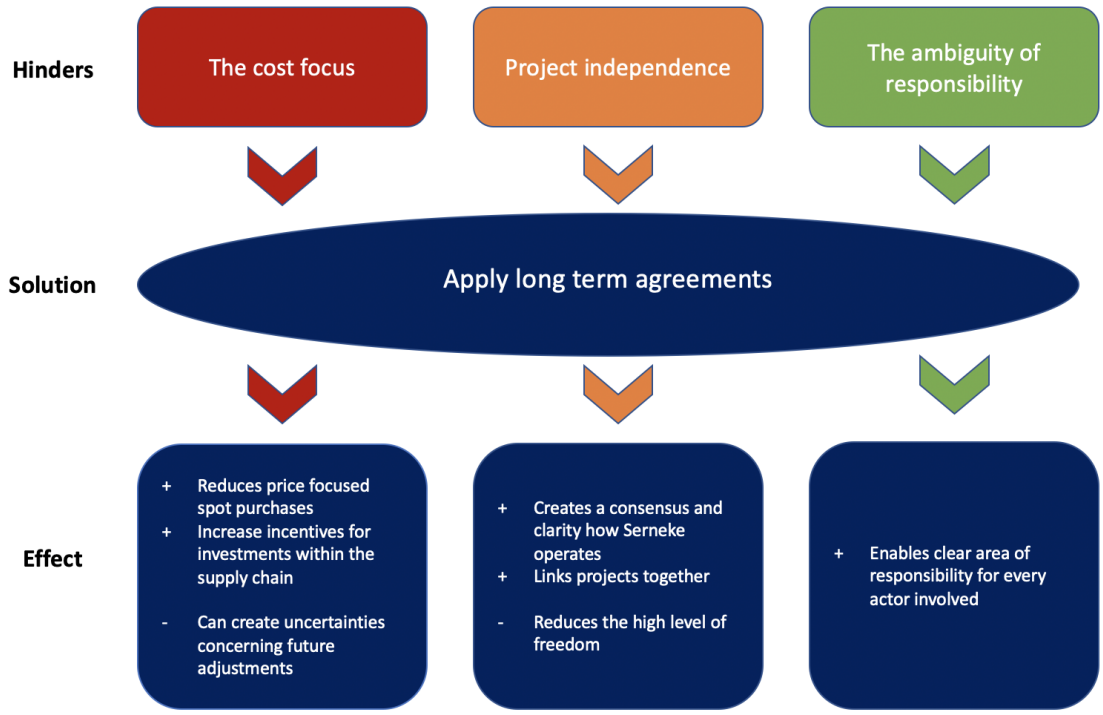

Figure 14: Solved hinders and effects of implementing the solution "Apply long term agreements"

Implement closer collaborations

If close collaboration and communication are achieved, it could be utilized in various ways. One way is to share knowledge and data when working with climate declarations. This is relevant for Serneke due to several reasons, not least since the Swedish National Board of Housing, Building and Planning acknowledges that calculated values will be more accurate compared to the generic ones as these are estimates (Boverket, 2021i). Likewise, the *HSEQ Manager* describes that if Serneke is good at calculating their emissions, they can gain advantages in the industry. If Serneke establishes a close collaboration with their suppliers, and in turn hauliers, it can enhance the work regarding calculating emissions from transports. Hence, functioning information sharing is beneficial since it will facilitate the development of climate declarations and reduce the level of uncertainty towards the collection of actual data. In addition to contributing to calculating emissions, an increased collaboration with suppliers would make it manageable for Serneke to request a separation of the actual transport and the material and by that solve the issue with having the transport included in the material purchase.

Furthermore, establishing closer collaboration with suppliers increases Serneke's possibilities to affect the transport process and the level of coordination. The *Purchasing Manager* emphasizes the lack of control as an evident issue that can be reduced by short communication routes. In the same way, the possibility for Serneke to work with suppliers in order to specify, and plan for, the material delivery process would foster the work by introducing environmentally friendly options.

Even if a close collaboration provides many positive outcomes, there is a risk of becoming too comfortable. If Serneke has a close agreement where the delivery terms are very flexible, the incentive for considering the environmental aspect can be forgotten. For example, if the delivery terms are "too good" it can cause a higher number of transports which affects the climate declaration as it increases the amount of emissions. Hence, the study suggests that the close cooperation may benefit from focusing on reaching the common objectives, not risking a higher number of transports by making the collaboration too flexible and not having any clear boundaries.

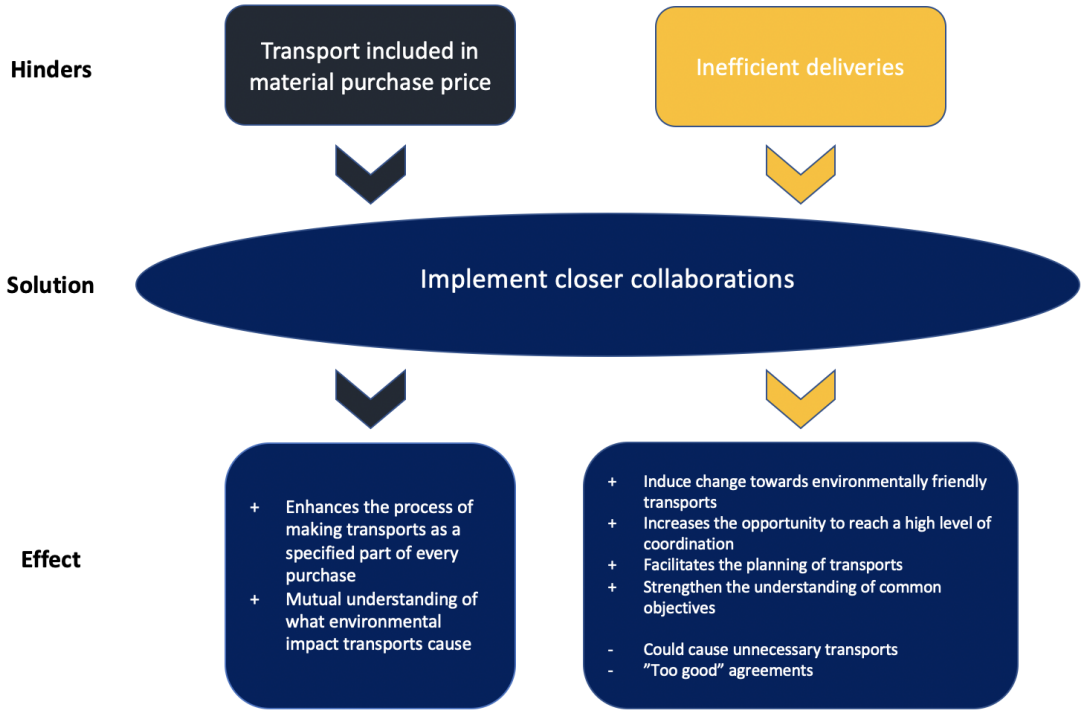

Figure 15: Solved hinders and effects of implementing the solution "Implement closer collaborations"

5.3 Construction transports contributions to Serneke's ambition to strengthen its competitiveness in regard to sustainability

One important factor for Serneke that the *Chief Sustainability Officer* highlights, is that if they want to strengthen their position, they need to decide if they want to be one of the leading actors towards an increased environmental awareness regarding transports. On the one hand, they can have a vital role and act as a role model and on the other hand, they can simply follow the requirements in terms of laws and regulations. The climate goals are receiving more attention and the demands are continuously assessed and intensified in order for Sweden to reach their climate

targets (Naturvårdsverket, n.d.b). Hence, this will affect the construction industry by introducing new requirements that actors accordingly need to adapt to. This could be exemplified through the new act for climate declarations, where transports of material are included.

The results indicate that there is no unified understanding regarding the possibility for Serneke to gain momentum within the industry simply by being good at constructing buildings with a low environmental impact. For Serneke to be able to overcome this divided perception, they need to start the company's internal work to make sure that everyone is on board and can adhere to the advantages. As the *HSEQ Manager* describes it is not about creating a vision that looks good on paper, but to cause action. Therefore, Serneke needs to develop a clear identity of being a company that keeps their promises and is not a company that says something and acts differently. Furthermore, Serneke's process of being a competitive company regarding their sustainability work may need to be made in several steps. The actual work that is performed in order to achieve the goals is not worthwhile if not followed up and continuously evaluated as the *Chief Sustainability Officer* emphasizes.

By focusing on creating a clear identity, one way forward can be for Serneke to acknowledge and propose additional values in their projects compared to only price. This is in line with the understanding that the *Energy & Climate Coordinator* presents, where focus needs to shift from valuing all products and services in terms of price, to a feeling of contributing to a more sustainable world. If Serneke wants to in the forefront among contractors within the industry, it is necessary to acknowledge price and sustainability as equally valuable throughout the whole organization and in each and every process. This way of thinking correlates with the existing framework for climate politics that the Swedish government should follow. In this framework, equal awareness is given to the climate and the budget (Naturvårdsverket, n.d.b).

When implementing different solutions that have been identified as efficient for a reduced climate impact, it is important to clarify what they can be used for. If there are several uses, it is important for Serneke to take advantage of this. As described in the previous section, a CCC is a solution that can reduce the environmental impact from transports. However, this is not the only benefit that it entails. For example, it can be used as a marketing tool in order to strengthen Serneke's position towards other stakeholders. By emphasizing that they actively are working for a better environment in the city they are able to strengthen their brand. Thereby increasing Serneke's ability to be in the forefront of the sector and lead change, hence, leaving the stage of only having good looking visions as the *HSEQ Manager* points out to be crucial. By operating in this way, Serneke would offer a complete concept and a clear identity, which is beneficial from several viewpoints. First, it is advantageous since it would put Serneke in a competitive position because actors within the industry will know that they put emphasis on their sustainability work and actively try to reduce the environmental impact from transports. Secondly, it solves the problem of not only saying but also doing, they have visible examples of how they are working with the climate issues related to transports.

Moreover, the identified solutions regarding better collaboration with suppliers as well as long term agreements are aspects that could affect Serneke in a positive way. When setting out to develop these long agreements with a clear environmental focus, it is important for Serneke to act with a mutual understanding in mind. In order to reach a beneficial outcome, these agreements need to not only fulfill Serneke's needs, but also recognize and be aware of suppliers' necessities and thereby develop a sense of a joint understanding as *Site Manager A* also claims. If Serneke is able to develop a sense of being the "preferred customer" to a few suppliers that Serneke would regard as "preferred suppliers", both parties would prioritize this collaboration which *Site Manager A* argues for.

On a project level, this type of high involvement collaboration could be assisted through the type of contract, for example, partnering. As the *Project Purchaser* and the *Purchasing Strategist* believe, the use of partnering could prevent the sense of "us" against "them". Therefore, the use of partnering and other types of collaborative contracts can be seen as one step towards creating a feeling that "we" are working together. Still, as the *Environmental Health & Safety Coordinator* mentions, it is vital to be aware that it is not enough to decide that a project will be performed through a partnering agreement. There should always be continuous assessments and follow ups regarding how the collaboration is progressing. Since every organization has its own structure and working methods, the collaboration needs to be tailored in a way that is preferable for every party. The ability to do so can be seen as a key component of whether it will be a success or not, as also previous research shows (Gadde and Dubois, 2010)

6 | Conclusion

The aim of this research revolves around exploring the current situation regarding material transports in Serneke´s projects as well as how the environmental impact can be reduced from implementing various solutions regarding transport organization. The following conclusions have been identified as crucial in this improvement process.

First, ***separating the material price and transport cost*** is key in order to strive towards a more environmentally friendly transport organization. Being a key component in a construction project, it is identified that material deliveries are struggling with low efficiency which originates from an absence of knowledge as well as a lack of control over the process. In addition, the fact that materials are often purchased "as delivered" is an obstacle when striving to achieve transports with a lower environmental impact. Consequently, the first conclusion revolves around the need to separate from material price when purchasing material, only when the information regarding the transport is specified it is possible to set requirements for it.

Second, it is key to ***make use of construction consolidation centers*** (CCC). It has been recognized that a CCC can increase the efficiency in a project as well as reduce the environmental impact from transports. In Sernekes situation, it is recognised that a CCC could be set up and serve several projects in the same area, in this way, the additional cost for the solution can be carried by several projects. Consequently, an increased use of a CCC is something that Serneke should investigate further if they want to reduce their environmental impact from transports. This solution can also provide other benefits for Serneke, for instance, it introduces a higher level of control over the transport process and enables Serneke to strengthen their brand through different initiatives such as electric vehicles within the cities. Also, the empirical data shows that just in time deliveries (JIT) are important in Serneke's projects, still, due to the lack of control over the process it is difficult to achieve this on every occasion. By implementing a CCC and thereby achieving higher control over the material delivery process, JIT is made more precise since the material is stored at the consolidation center and only driven the last stretch to the site.

Third, it is identified that ***knowledge regarding the logistics setup and the material delivery process needs to be improved*** in order to be able to imple-

ment environmental criteria, especially when deploying a logistics solution such as a CCC. Therefore, it is concluded that Serneke needs to make a strategic decision regarding if this necessary competence should be developed in-house or accessed by an increased collaboration with an external logistics provider.

Fourth, closer, more ***long-term collaborations with suppliers*** is a solution that in the long run could reduce Serneke's emissions from material transports. It is concluded that short-term agreements together with low involvement interactions causes a low utilization of transport services. Instead, by implementing more long term agreements with suppliers, Serneke could together with their supplier strategically work to achieve environmental benefits in the delivery chain. Serneke cannot achieve a transition to environmentally friendly transports by themselves, they need to do it together with their suppliers, hence, the need to engage in close, more long-term collaborations with suppliers. Potentially this also implies that Serneke might have to reduce its supplier base in terms of total number of suppliers, as closer collaborations are more resource intensive to mandate.

Finally, working with transports is one important component in Sernekes strategy along with other sustainability actions. The future work includes many aspects that need to be connected to and coordinated with construction transports. The proposed conclusions in this study assist in the transition towards a sustainable construction industry, by increasing the understanding how the transports should be conducted with the lowest impact possible. At the same time, the study presents the identified solutions and identifies how they should be used in order to improve Serneke's competitiveness in terms of improved sustainability within the industry.

6.1 Future research

There are several areas that could be analyzed further in order to assist the development towards sustainability within the construction industry. Firstly, a detailed study on transport vehicles with a focus on the capabilities of new electric powered lorries could increase the willingness within the industry to invest in these vehicles. Secondly, Serneke needs to establish the cost difference involved in implementing a CCC with either in house personnel or through a TPL, as well as perform some pilot project in order to test the solution on a wider scale where the CCC serves several sites. Lastly, the development toward having material and transports as two completely separate processes needs to be studied in order to facilitate and hurry up the process.

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Appendix A

Interview questions

Generell information:

- Kan vi spela in intervjun?
- Namn och roll? (Du kommer vara anonym och vi kommer inte använda ditt namn i rapporten)
- Kan du beskriva din bakgrund, erfarenhet och mer ingående om din nuvarande roll på Serneke?

1. Hantering av logistik och transporter

- nuläget, hur upphandlas transporter till projekt på Serneke?
  - Finns det några standardlösningar för era projekt? Eller är det alltid olika?
  - Ingår transport i materialinköp?
  - Vilka krav ställs vid upphandling av transporter?
- I
- I komplexa och omfattande projekt, använder ni er av externa aktörer som är specialiserade specifikt inom logistik? Som assisterar er och hjälper er att hantera logistiken kring projektet?
  - Om ja, har ni några specifika krav på att de ska utföra deras lösningar med ett utvecklat miljötänk?
- Hur ser ni på olika logistiska metoder/system som exempelvis:
  - Konsolideringscenter
  - Just in time deliveries (JIT)
    - Tror du att det finns en risk att JIT leveranser försvårar en minskad klimatbelsaning från transporter då leveranser bryts ner i mindre ”bitar” vilket kör att fler transporter behöver köras?
  - Arbetar ni med några andra system för att hantera logistik och transporter istället eller i kombination med de nyss nämnda?
  - Leveranscontainer på byggplatsen?
- Arbetar ni strategiskt med att hantera er supply chain av material?
  - Sker det någon utveckling av gemensamma lösningar?

2 .Utmaningar med transporter/ dess miljöpåverkan

- Vilka upplever du är de största utmaningarna gällande transporter med avseende på miljöpåverkan inom era projekt?
- Upplever du att ni bör ställa ytterliga miljökrav mot era leverantörer avseende transporter?
    - I så fall vilka?
- Hur påverkar ett projekts samarbetsform er möjlighet att påverka hanteringen av transporter?
    - Tror du det finns det någon samarbetsform som är fördelaktig för att kunna ställa krav på hållbara transporter?

3. Klimatdeklaration

- I de fall där ni agerar byggherre, har ni tagit fram något ramverk för att upprätta klimatdeklarationer (specifikt för transporter inom A4)?
- När ni agerar entreprenör, vilka krav på att redovisa detta får ni från kund?
    - Upplever du att det finns skillnader mellan offentliga och privata byggherrar?
- Hur arbetar ni då med insamling av data för dessa klimatdeklarationer?
    - Vilka uppgifter efterfrågar ni av era leverantörer avseende transporttjänster?
- Ser du att ni bör ställa ytterligare krav ang. den information som leverantörer lämnar angående transporter?
- Vilken effekt tror du kravet på klimatdeklaration kommer ha i längden?

4. Potentiella lösningar för minskad klimatbelastning

- Ser du några lösningar för att kunna minska klimatpåverkan på grund av transporter av material till byggarbetsplatsen?
    - Vilka utmaningar ser du för att dessa lösningar ska kunna bli realiserbara?
- Tror du att det behövs några ytterligare bestämmelser eller lagar för att ni på Serneke ska kunna lägga resurser på att utveckla hållbara transportlösningar?
- Vad ser du är den faktiska nyttan av att arbeta aktivt för att reducera transporter?
- Vad ser du för incitament för att minska transporter inom Serneke? (utöver ett krav att klimatdeklarera eller om kund önskar mindre transporter)

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