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Property Owners Role in Construction Logistics

A study analysing the construction logistics contribution towards a sustainable construction industry

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

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Abstract

The construction industry is one of the main contributors to CO_2 -emissions in Sweden. Action needs to be taken to achieve the targets of net zero emissions by 2045 and already by 2030 in Sweden's three largest cities. Construction logistics have the possibility to reduce climate impact and improve the performance of the construction industry. The study pursued to determine how property owners could work with construction logistics. Besides new laws and regulations, property owners drive innovation in the sector. This study aims to highlight the opportunities for property owners in terms of construction logistics.

This is a qualitative research study using semi-structured interviews to gather data. The interviews have been carried out with people from several property owner's organisations, as well as with people from contractors, logistics suppliers, urban developers, and academia. The results show that property owners rarely put specific requirements on construction logistics. Consequently, construction logistics is a hidden cost that is seldom monitored. Despite this, the property owners seem to see potential in construction logistics as several driving forces were mentioned. Reduced CO_2 -emissions and reduced amount of transport are the most frequently mentioned drivers. The result shows that property owners should place requirements in an early stage on construction logistics in order to improve productivity and reduce climate impact in future projects.

The study concludes that the view of construction logistics in the sector is fragmented. Simultaneously, a majority of property owners express an interest in construction logistics, acknowledging that there are several driving forces that can help them improve sustainable development and thus mitigate their impact on the climate. In order to maximise the potential benefits of construction logistics, property owners ought to assume greater accountability while ensuring construction logistics' early implementation.

Keywords: Property owners, Construction logistics, Requirements, Sustainable development

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Acronyms

CCC	Construction Consolidation Centre
CLS	Construction Logistics Setups
ICT	Information and Communication Technology
JIT	Just-in-Time
SCM	Supply Chain Management
TPL	Third Party Logistics

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1

Introduction

The property owner is a demand-setter in the early stages of the construction process and is responsible for setting clear requirements for the contractors in order to complete the ordered project (Thompson, 1991). In this study, the property owner's role will be investigated in relation to the concept of construction logistics to find current ways of working with construction logistics and also try to find possible ways of working with construction logistics in the future.

The report is a combination of an empirical study and a literature overview that will investigate working methods and processes to analyse the role of property owners in construction logistics in dense cities. This section consists of a description of the background to the thesis, the aim of the project, the research questions, delimitations and lastly, the thesis outline is described.

1.1 Background

Urbanisation and densification are factors that have characterised the development of cities in the last centuries (Guerlain, Renault, & Ferrero, 2019). In 2018, 55% of the world's population lived in cities and 68% of the world's population is expected to live in cities in 2050 (Guerlain et al., 2019). This number is even higher in Sweden, according to Statistics Sweden (2022), 88% of the residents lived in urban areas in 2020. Urbanisation in combination with ambitious environmental goals in the coming years puts pressure on the construction industry as this trend of urbanisation results in an increasing demand for developing buildings and infrastructure in city centres.

Boyd and Chinyio (2006) describe the construction industry to be an industry that develops the constructions and infrastructure that support all forms of economic development. Additionally, construction is a significant employer and resource user, which contributes to a healthy economy. In 2021, the Swedish construction industry represented 11% of the nation's gross domestic product (Byggföretagen, 2022). This indicates that the industry has a great impact on the economic development of Sweden. At the same time, the construction industry is one of the main contributors to environmental impact. In Sweden, the construction industry contributes to 21% of the CO_2 -emissions, which corresponds to 9.8 million tonnes CO_2 -equivalents

(Boverket, 2023a). In conjunction with this, large amounts of emissions are related to the importation of materials, if these amounts are included, the amount of CO_2 -equivalents associated with the construction industry rises to 15.9 million tonnes CO_2 -equivalents (Boverket, 2023a). Statistics from Boverket (2023a) show that production increases at the same time as the amount of emissions decreases. However, as Sweden is striving to reach a target of net zero emissions by 2045, measures are still needed to reach the target.

The combination of increased demand for construction due to urbanisation and the targets for net zero emissions by 2045, places demands on the construction industry. In addition to these challenges, the construction industry suffers from delays and cost overruns (Boyd & Chinyio, 2006). These issues are well known within the industry and research shows that in addition to this, there is a lack of productivity (Agapiou, Clausen, Flanagan, Norman, & Notman, 1998; Dubois, Hulthén, & Sundquist, 2019; Guerlain et al., 2019; Vrijhoef & Koskela, 2000).

Construction logistics has been identified as a crucial solution when trying to manage the challenges mentioned above that can be related to workflow and waiting times (Guerlain et al., 2019; Vrijhoef & Koskela, 2000). There are several definitions in the literature that describes construction logistics, the one that will be used in this study is from Lambert and Cooper (2000) where construction logistics management (CLM) is defined as:

Logistics is that part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from the point-of-origin to the point-of-consumption in order to meet customers' requirements.

(p.67)

In the theoretical framework will different construction logistics setups be described that can improve the progress of construction projects. Vrijhoef and Koskela (2000) outline how improved supply chain management (SCM) can reduce costs and shorten the time of activities. They describe how SCM can decrease interruption of work and material flow, waiting and lead times, by increasing off-site production and improving collaboration between supply chains. Further, Guerlain et. al. (2019), imply that using a construction consolidation centre (CCC) and focusing on optimising construction transports can minimise problems with delays and ensure that resources are used more efficiently. The planning of material flows and transports are important to ensure that a project is completed within the specified time frame, under the right conditions and for an acceptable price (CIVIC, 2018). Research studies have demonstrated that the implementation of thoughtfully designed construction logistics strategies can improve efficiency by 25-30% and reduce transportation by 60-80% (Abrahamsson, Fredriksson, Hüge Brodin, Engevall, & Lindahl, 2019).

As mentioned above, the literature shows potential for improving project performance through construction logistics. This study is based on the perspective of

property owners, as so far there has been little research on the possibilities of property owners in terms of construction logistics. Property owners, i.e., the client, are responsible for setting clear requirements, making the appropriate decision, and ensuring that the project is completed successfully (Thompson, 1991). For a long time, a significant focus has been placed on developing specialised professions within the industry, and despite the importance of the client, research regarding their role in the industry has not been prioritised (Challander & Whitaker, 2019). Due to the property owner's early involvement in the construction process, property owners have the ability to influence the specifications of the project and its subcontractors. This gives them more options to influence time, price, and quality outcomes through a variety of strategies, such as construction logistics.

1.2 Aim

The aim of this study is to investigate the potential of construction logistics for property owners to develop a more sustainable construction process. Property owners in the context of construction logistics are rarely mentioned in the literature despite their important role in the realisation of a construction project. The ambition is therefore to propose suitable future strategies for property owners to work with construction logistics.

1.3 Research Questions

In this section, the issue under investigation is presented. The questions are answered from the perspective of the owner of the property. When discussing sustainability, all three aspects, economic, environmental, and social, are investigated.

RQ1: *How do property owners work with construction logistics today?*

RQ2: *Which are the main drivers to work with construction logistics for property owners from a sustainability perspective?*

RQ3: *How should property owners work with construction logistics in the future?*

1.4 Delimitation

Construction logistic solutions can be initiated from different driving forces, in this master thesis, the relationship between property owners and construction logistics will be investigated and analysed. The main focus will be on the sustainability effects. The data will be collected through interviews which will result in a qualitative study, thus, there will not be any environmental calculations performed nor any cost calculations. The study will be limited to a Swedish context with a focus on property owners developing properties in the Swedish market. The property owners will operate in dense areas, with a focus on large cities. Due to the time frame of the project, this master thesis does not consider municipalities as respondents. Contribution from contractors, logistics suppliers, and academia will enable a broader understanding of the topic and strive to find suitable improvement suggestions for property owners. This master thesis is addressed to people who are acting or interested in the construction industry; therefore, it is assumed that the reader has some basic knowledge about the construction industry.

1.5 Thesis Outline

This master thesis begins with a presentation of the background that briefly describes the current state of the construction industry and its contribution to climate impact. The introduction continues with a description of the purpose of the study, research questions, and delimitations. The second chapter 2 Theoretical Framework, provide a theoretical overview of the construction sector, a description of the property owner which is the chosen perspective of this study, followed by a part about construction logistics. The collected data has been gathered through interviews, more information about the used method is provided in chapter 3 Methodology. The methodology chapter ends with a discussion that critically evaluates the research process. The collected data is presented in chapter 4 Result, this chapter is divided in three subsections where each chapter presents results for each of the research questions. Chapter 5 Discussion compares the theoretical framework and the results. The discussion is followed by a concluding chapter describing the summarised recommendations for property owners 6 Recommendations for Property Owners where the results of the study have been compiled, answering the last research question. The conclusion of this study is presented in chapter 7 Conclusion where the found answers to the research questions are summarised, finally suggestions for future research are presented.

2

Theoretical Framework

The following chapter presents the theoretical framework that provides the foundation for the results and discussion in the thesis. The theoretical framework starts with an overview of the construction industry, followed by a chapter on the construction sector from the perspective of the property owner. Thereafter, the construction supply chain is presented with a focus on construction logistics. The chapter then describes various construction logistics setups (CLS), the impact of the construction sector on sustainability and how the performance of logistics solutions can be measured.

2.1 Overview of the Construction Industry

The construction industry is one of the main drivers of economic development and plays an important role in a country's development (Boyd & Chinyio, 2006). The construction industry is characterised as a project-based industry where every project is unique and assembled on site (Challander & Whitaker, 2019; Vrijhoef & Koskela, 2000) and where every project is driven by a temporary organisation (Morledge & Smith, 2013). These characteristics result in an industry which is distinguished by unique prerequisites and little repetition (Vrijhoef & Koskela, 2000). In contrast to other industries, a construction company's profitability is usually considered to be exceedingly low (Briscoe, Dainty, Millett, & Neale, 2004). The construction industry is also known for cost overruns, time delays, and low productivity (Boyd & Chinyio, 2006; Briscoe et al., 2004).

Construction projects contain a number of different phases that eventually will end up in a building, facility, road, bridge, or tunnel. Since this thesis focuses on property owners, a project refers to a building. Each phase and activity include a large number of people and organisations, called stakeholders, with an interest in the project. During each of these phases, a multitude of activities is undertaken to ensure the successful completion of the project (Chinyio & Olomolaiye, 2010). These phases and activities are presented later in the thesis. Furthermore, Challander and Whitaker (2019) mean that construction is characterised by great risks for all parties since construction projects normally entail expensive price tags. The client takes considerable risks as the end price and satisfaction of the end product are unknown in advance. The risks associated with the contractor differ depending on the contract

form, but generally, the benefit from a project is unknown in advance.

In a construction project is the stakeholders closely interrelated to each other (Chinyio & Olomolaiye, 2010). Clients, consultants, and contractors are internal stakeholders with a legal agreement and are highly correlated during most of the process. External stakeholders such as local residents, government authorities, and trade unions are stakeholders that will impact or become impacted by the project through connections which are not immediate. The government is an important external stakeholder because of its power to start or end projects they co-finance, this is done to stimulate or suppress the economy (Boyd & Chinyio, 2006).

According to Boyd and Chinyio (2006) there are three main concerns within the construction industry for clients, especially, fragmentation, productivity, and performance. Fragmentation is the result of many stakeholders being involved in the same project but with different tasks and different objectives. This is not an unexpected problem as each actor belongs to a different organisation to which they are more loyal to than the temporary construction project organisation (Boyd & Chinyio, 2006). The issues regarding productivity occur due to uncertainty in the supply chain, varying site conditions and varying capacity conditions (Vrijhoef & Koskela, 2000). Ekeskär and Rudberg (2016) describe similar reasons for the low productivity in the industry, they mention that workers spend 30% of their time waiting and 20% of their time moving materials and equipment to the right place. As a result, the machines were used a maximum of 50% of the time. In addition to this, less than 40% of the deliveries arrived according to the order and without damage. Ekeskär and Rudberg (2016) argue that these issues regarding low productivity could possibly be limited by an increased focus on construction logistics. The construction industry has not succeeded in adopting new techniques that have improved performance as other industries (Dubois & Gadde, 2002; Sundquist, Gadde, & Hulthén, 2018). In section 2.6 Measuring Logistics Performance in Construction is performance further addressed.

As mentioned above, the construction industry has not developed in the same way as other industries. Several authors have outlined differences between the construction industry and other industries. One difference mentioned by Challander and Whitaker (2019), is that in the manufacturing industry, for example, the customer is usually aware of the price, quality, and delivery date of a product before the contract is signed, in this way, there are almost no risks for the customer. Vrijhoef and Koskela (2000) add that manufacturers often sell multiple products to many customers. Winch (2003) means that the significant participation of the client in the construction process is one of the main characteristics that distinguish the construction sector from other industries. However, Morledge and Smith (2013) claim that fewer investments are done in the construction industry compared to other industries, instead, Morledge and Smith (2013) imply that innovation is driven by changes in laws.

2.1.1 Construction Phases

As mentioned earlier, construction projects involve various phases, activities, and organisations. Depending on the perspective and form of contract, the phases can be expressed differently (Fewings & Henjeweale, 2019). Within the construction industry, it is rare that the same organisations are included throughout the whole project (Fewings & Henjeweale, 2019). Regardless of the specific method of division, it is apparent that the construction project can be viewed as a life cycle with distinct components. Susong (2006) describes the construction phases as "an art of coordination and management that must occur at every step to keep any construction project on schedule and on budget" (p.4). Figure 2.1 present the project life cycle from a client's perspective divided into three phases including the main activities of each phase. The figure refers to a property owner involved in the whole process.



Figure 2.1: Three phases of the construction process, based on an interpretation of Boverket (2021b) and Fewings & Henjeweale (2019).

2.2 Introduction of the Property Owner

The client, in this report, referred to as the property owner, is the initiator of construction projects and is responsible for the building after completion of the construction project. Kamara et al. (2002) define a client as:

A client can be defined as the person or organisation responsible for commissioning and paying for the design and construction of a facility (e.g., a building, road, or bridge) and is usually (but not always) the owner of the facility being commissioned. The client can also be the user of a proposed facility, or they (i.e., the client and user) may be separate entities.

(p.1)

Some responsibilities the property owners have during the construction are according to Kometa, Olomolaiye, and Harris (1995) in-house planning and design, project finance, project implementation, project definition, legal agreements, schedule duration, and contracting. As mentioned earlier, the construction sector is characterised by unique one-off products, meaning that each client has their own demands and requirements that the customer should fulfil within a new set of project teams (Challander & Whitaker, 2019). In order to ensure project success, it is essential to align the ultimate goals with the needs and desires of the property owners, including their goals, visions, and ambition

Property owners play a crucial role in the construction sector as they are typically the creators and financiers of projects, serving as the driving force behind what is developed (Challander & Whitaker, 2019; Chinyio & Olomolaiye, 2010). Depending on who owns a project, there are two different types of property owners (Chinyio & Olomolaiye, 2010). These two types are private property owners and public property owners. Public property owners are organisations owned by the state, which have the power to acquire public funding from the pre-construction to the final stage of a construction project. They are also required to take the needs of the general public into account, whereas private property owners typically place a larger emphasis on the financial profit of a project. Private property owners can be private persons, companies, or organisations (Nordstrand, 2008). The property owner may also appoint a representative to act on their behalf with delegated authority (Boyd & Chinyio, 2006). In such cases, the representative acts as the client, yet the property owner assumes responsibility upon project completion and obtains the financial benefit.

The perception of construction projects among clients is varied, as described by Boyd and Chinyio (2006), who categorise them into three distinct groups: uninformed or naive customers, partially informed customers, and well-informed or sophisticated customers. Well-informed or sophisticated customers, as the property owners in this thesis, often perform projects in construction or have a background in the sector. The fact that perceptions vary has a major impact on the sector and places high demands on all involved. One reason is that everyone involved needs to be aware of the knowledge and perceptions of others (Boyd & Chinyio, 2006). Some clients require that activity around the construction should be able to proceed more or less normally in parallel with the execution of the construction (Sullivan, Barthorpe, & Robbins, 2010). In these kinds of projects, there is often a lack of space, warehousing, and the possibility to create a permanent construction site is limited. In these cases, it is common that the client requirements emphasise quick completion of the construction in order to return to normal as quickly as possible without disturbing the surroundings or others (Sullivan et al., 2010).

As earlier defined by Kamara et al. (2002), a property owner is the investor of the project and later the operator of the building. A study made by Winch and Leiringer (2016) identifies different client capabilities to achieve good results in infrastructure projects. These capabilities describe what is required by the owner organisation to successfully broaden and develop their capacity depending on the project. Many owner organisations do not see development as their core business, this creates a

barrier which leads to difficulties in learning. Winch and Leiringer (2016) describe three different fields whereby the owner needs competence. These three fields are:

- **Strategic capabilities** - Such as selecting projects, defining why the project is being carried out, acquiring a budget, and dealing with stakeholders.
- **Commercial capabilities** - Such as work breakdown structure strategies and management of contract and procurement.
- **Governance capabilities** - Such as ensuring the appropriate resources in the owner organisation to govern and coordinate the work.

Whereas, Winch (2016) means that strategic capabilities only involve the owner's organisation and their responsibilities. Commercial and governance capabilities on the other hand involve the skills required to manage the interface between the owner organisation and the project-based organisation. To manage this interface is an important factor for the client to create an effective workplace and an improper allocation of tasks results in an ineffective use of this (Wen, Qiang, & An, 2017).

2.3 Contract Forms and Requirements in the Construction Industry

Within the construction industry, the property owner chooses the form of contract and payment method as well as formulates requirements. Firstly, this section describes common forms of contracts, followed by recommendations regarding requirements from the literature.

2.3.1 Form of Contract

As mentioned in section 2.1.1 Construction Phases the choice of contract is part of the pre-construction phase, see figure 2.1. This is an important part of the process since it sets the stage for the development of the project. There are primarily two different types of contract forms used in the construction sector, design-bid-build contracts and design-build contracts (Ling & Kerh, 2004). In Sweden, these contracts are regulated by General Conditions of Contract for contracts and consulting assignments, negotiated by stakeholders in the industry. Connected to these two types of contracts are two standard contracts, ABT 06 for design-build contracts and AB 04 for design-bid-build contracts where design is the client's responsibility (Boverket, 2023b). These two types of contracts determine how the work should be performed and the responsible actor for the different activities. The Construction Contracts Committee (2004) defines the two different types as:

- **Design-bid-build** - agreements in which the client is responsible for the design and the contractor is responsible for the construction.
- **Design-build contracts** - agreements in which the contractor is responsible for both the design and the construction of the project.

When a design-bid-build contract is used, the client is responsible for carrying out investigations and preparing drawings, technical solutions, and other relevant documents (Projektledning, 2021). This type of contract puts high demands on the client and all design documents (Projektledning, 2021), as the contractor only participates in the project during the construction phase and not in the design phase (Challander & Whitaker, 2019). Apart from the design, the client is responsible for the control of the work and for monitoring that the contractor executes the work as contracted (Boverket, 2021a). In this type of contract, the contractor has no responsibility for the function of the building, only that the work is carried out professionally. According to Challander & Whitaker (2019), there is little confidence in the construction industry in terms of client satisfaction, pricing, and make accurate time schedules. Design-bid-build contracts are seen as one reason, since they do not engender trust between the parties. The fact that the contractor is not involved in the planning may also explain why the stakeholders blame each other when an error occurs instead of focusing on unity. In addition to lack of responsibility, Ling and Kerh (2004) believe that design-bid-build contracts are limited by the fact that this form of contact includes restrictions such as poor implementation of innovation and may lack productivity.

In a design-build contract, it is instead the contractor that is in charge of carrying out investigations and preparing drawings, technical solutions, and other relevant documents (Projektledning, 2021). This work is based on performance-based specifications and functional requirements that the client demands. The client focuses on defining the project goals and outcomes, not specific design details. The contractor is then responsible for ensuring that the design of the project that they produce meets the functional requirements set by the client. In this form of contract, the contractor has a larger responsibility for the final product than in a design-bid-build contract (Boverket, 2021a). However, according to Projektledning (2021), it is usual for the client to determine at least some of the work by providing the contractor with detailed technical solutions.

Ling and Kerh (2004) believe that there is little variation between the performance of design-bid-build and design-build contracts. They imply that there is a need to look beyond the contract type to control the project performance. Further, Ling and Kerh (2004) mean that property owners commonly choose the form of contract based on what they are used to using or due to recommendations.

In order to ensure the responsibility of each stakeholder, it is crucial to study the contract agreements (Projektledning, 2021). The contract should also make it clear which standard clauses will apply and what is added or changed. Once the contract is signed, it constitutes the foundation for what is included or not included in the price. If anything is changed, added, or removed, it will affect the final price.

In addition to these two types of contracts, there are several varieties. One of these is known in the construction sector as partnering contracts, which are based on increased cooperation between clients and contractors. The aim of this is to decrease risk and share profit and additional costs (Boverket, 2023b). Partnering can be applied regardless of the form of contract and type of procurement (Byggherrarna, 2018). Byggherrarna (2018) implies that partnering prerequisites that the payment method cost-plus fee or lump sum and cost-plus is used. A sole lump sum is not appropriate as it increases the risk for the contractor and therefore contradicts the collaboration between the parties if unforeseen costs arise.

When the form of contract is decided, the property owner decides which form of procurement should be used. In Sweden, there are two different types of procurement; divided contract or general contract (Boverket, 2023b). With a divided contract, the client obtains and establishes contracts with all necessary contractors for the construction project, and the different contractors work independently from one another. If a general contract is applied, the property owner hires a single contractor who serves as the general contractor for the construction project. The general contractor then obtains and contracts with the necessary subcontractors, who work independently from one another. The interaction between the various contractors and the number of contractors that the property owner hires are governed by these two different forms of procurement (Boverket, 2023b). The form of procurement used must be specified in the request for quotations documents. This documentation is a group of documents which the developer provides to contractors throughout the procurement process. It must include all requirements for contract procurement in building projects.

Historically, the construction sector has been characterised by tenders with the lowest price winning the bid which often results in disputes between client and contractor (Challander & Whitaker, 2019). The more responsibility that is added to the contractor, the more difficult pricing becomes, and the more unknown variables involved, the more difficult it is for the client to choose the most suitable tender. If the requirements are unclear for the tendering contractor, it can lead to disagreements (Morledge & Smith, 2013). To avoid this, alternative procurement forms can be chosen by the client, the aim of this is to share risk and return.

2.3.2 Requirements

According to Winch (2009), the construction sector has long been characterised by designers and contractors bidding too low to win projects, relying on making a profit due to poor specifications and late changes by clients. Well-defined requirements make it more difficult for contractors to underbid. Since it is the client who sets the requirements, Byggföretagen (2020b) believes that the client has great opportunities to put high demands on the innovation of climate-smart solutions and it can be a force to develop the sector. Therefore, this section will investigate what the client can have in mind during the pre-construction phase regarding requirements based on the available literature.

As mentioned in the definition of a client, this is the person or organisation that pays for the construction project. To enable a successful completion of a project and satisfy the client, it is important to fulfil the client's requirements. As the requirements are the primary source of information, it is important that these are clearly defined (Kamara et al., 2002). Even if the client is the one that will use or invest in the construction project, it does not necessarily mean that the client is familiar with the construction industry; therefore, it can be a process to collect the list of requirements. Firstly, the requirements of the building or facility are conveyed in non-design terms and later translated into design terms, to ensure that the requirements align with the client's expectations (Kamara et al., 2002). In a construction project, there are different types of requirements besides the client requirements, for example, site requirements, environmental requirements, regulatory requirements, and design and construction requirements.

The client requirements should clearly reflect what they aim to achieve with the project and which functions that are requested (Kamara, Anumba, & Evbuomwan, 2000). As a property owner, it can be difficult to set the right requirements that are clear enough for the contractor in the pre-construction phase. Therefore, it can be reasonable to include contractors in an early phase to be able to produce a proper request document. The property owner can therefore make a request for information that is sent to possible contractors, where they respond with thoughts regarding which requirements and which clarifications are needed in the request documents. If this process is performed, it can gather advantageous solutions and decrease the risk of delays and cost overruns later in the project (Byggföretagen, 2020c). Byggföretagen (2020c) emphasise that tough requirements necessarily do not result in better projects, requirements cost money and need resources both for the contractor and client, therefore it is important to not have too high requirements and also be able to make sure that the requirements are full-filled. Section 2.6 Measuring Logistics Performance in Construction describes different ways of measuring the performance of logistics requirements. Kamara et al. (2002) recommend that the client requirements should be:

- precise and straightforward
- holistic
- allow different solutions to facilitate innovation
- understandable for all actors in the project

The client is responsible for enabling a safe work environment during the construction phase and a safe building after construction (Arbetsmiljöverket, 2022). The construction industry is the only industry where the client both has the work environment responsibility during the construction phase and when the building is in operational use. Furthermore, work environment requirements should be clearly stated in the request documents and they must be taken into consideration by the contractor (Boverket, 2020a). In Sweden, the client needs to follow the Planning and

Building Act, the Planning and Building Ordinance, and Boverket's Buildings Regulation. Boverket mentions that the client can have an obligation to follow other rules as well that is not regulated in the Planning and Building Act (Boverket, 2020a).

2.4 Construction Supply Chain Management

As mentioned previously, the construction industry is lagging in productivity development (Vrijhoef & Koskela, 2000). Ekeskär and Rudberg (2016) argue that problems regarding high costs, a large amount of waste, and waiting time can be limited if the construction industry places more focus on SCM and construction logistics. Also Briscoe et al., (2004) argue that cost overruns, time delays, quality problems, and incidents can be improved by SCM. In this section management connected to logistics in the construction industry will be described.

Lambert and Cooper (2000) argue that the supply chain should not be seen as a chain, but rather a network of numerous actors and relationships, they have defined SCM as:

Supply Chain Management is the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders.

(p. 66)

According to Lambert and Cooper (2000), most companies are involved in multiple supply chains, they argue that SCM is about managing key supply chain processes and not only individual functions. Vrijhoef and Koskela (2000) have identified four roles of supply chain management that should be prioritised to manage the characteristics of the construction supply chain mentioned above. The first role aims to focus on material and workflow to the construction site to minimise disruption and thereby reduce costs and duration of activities, Vrijhoef and Koskela (2000) implies that the contractor is in the main position of affecting this first role. The second role aims to reduce costs in the supply chain through optimising logistics, lead time, and stockpile. Just as the first role, the third aims to reduce costs and duration of activities, this role focuses on off-site production to reduce the number of activities needed on-site and to increase the industrialisation of the construction. This change of working could be proposed by either suppliers or contractors. The fourth role aim to improve the supply chain both off-site and on-site through more integrated management, this focus can be proposed by either clients, suppliers or contractors. In the article written by Vrijhoef and Koskela (2000) is a fifth role described, they imply that property owners have a unique role where they can improve all four roles at the same time if they have adequate construction volumes. Since they are part of a bigger picture than just the specific construction project where the contractor and suppliers have been assigned to deliver a project the client can improve the construction supply chain. Further, the client has the opportunity to drive change

and improvement of the supply which can improve the performance of their projects (Challander & Whitaker, 2019; Vrijhoef & Koskela, 2000). Challander and Whitaker (2019) have also identified the client to be in a position with the ability to influence the degree of integration in the supply chain.

2.4.1 Logistics Management in Construction

Logistics is about delivering the right material in the ordered time, in the right location and at the right cost, therefore, transportation becomes a large part of logistics, up to 10-20% of the construction costs can be related to transportation (Sullivan et al., 2010). When discussing logistics, it refers to managing activities to be cost-effective, strategically suitable, and optimal distribution of resources to meet the needs of the end-user (Sullivan et al., 2010). Logistics management are defined by Christopher (2016) as:

Logistics is the process of strategically managing the procurement, movement and storage of materials, parts and finished inventory (and the related information flows) through the organisation and its marketing channels in such a way that current and future profitability are maximised through the cost-effective fulfilment of orders.

(p. 2)

Paying attention to the delivery of material to the construction site and increasing traceability in the supply chain from the construction to the post-construction phase are according to Egan (2002) important. This can feasibly increase productivity, reduce the production of waste, improve social and ecological sustainability, and improve digitisation in projects.

2.4.1.1 Coordinating Logistics

To achieve efficiency and effectiveness in a construction project the integration of supply logistics and site logistics plays a crucial role (Dubois et al., 2019). Supply logistics encompass operations like requirements, purchasing, and transportation of materials to the construction site, whereas site logistics comprise material flow management and logistics coordinating on the construction site. Abrahamsson et al. (2019) imply that planning of construction logistics could possibly reduce transportation by 60-80%, this could also increase the efficiency in the construction industry with 25-30% due to reduced duration of activities and reduced number of deliveries to each construction site. Based on supply logistics and site logistics Dubois et al. (2019) describe three different coordinating configurations. These configurations vary depending on the arrangement of activities on-site and off-site and on the interface between these. The different coordinating configurations are called de-centralised, on-site and supply network.

The de-centralised coordinated configuration is described by Dubois et al. (2019) to be a configuration where the supply chain between contractor and subcontractors is separated. Everyone that is involved is responsible for their own activities connected to handling materials and planning logistics. When the schedule is changed, logistics activities are not included and the schedule is therefore changed only with respect to production. The lack of cooperation and planning of logistics activities can lead to poor organisation of materials both outside and inside the workplace, such as multiple transports and relocation of materials. According to Dubois et al. (2019) materials are transported around the construction site an average of seven times and construction workers spend approximately 15% of their working hours searching for gathering, and transporting materials as they switch between handling materials and engaging in production-related tasks.

The on-site coordinated configuration refers to the logistics operations on-site and the supply chain interface being jointly organised (Dubois et al., 2019). However, transportation and logistics activities to the site are managed independently. This configuration is usually used when there is a lack of space on-site or if the project is complex and requires the involvement of a logistics manager. Dubois et al. (2019) argue that the blue-collars can focus on what they are good at and that it is possible to lower the working hours at the site when the blue-collars are not participating in the material handling.

The supply network coordinated configuration is based on the same foundation as the on-site coordinated configuration, the difference is that the supply network also involves a shared collaboration of the supply chain outside the workplace (Dubois et al., 2019). This results in a reduction of transports to the construction site, and the suppliers are ordained to consolidate material at a consolidation facility located off-site. This type of arrangement is called CCC and is explained in section 2.5.1 Construction Consolidation Centre.

2.4.1.2 Logistics Manager

Agapiou et al. (1998) argue that early implementation of construction logistics planning is essential for maximising project productivity. Further, Sullivan et al. (2010) state that planning is everything. In order to monitor and manage the logistics chain, it is advantageous for the project to introduce construction logistics in the pre-construction phase. To successfully plan the logistics of a project, a logistics manager can be a useful tool (Sullivan et al., 2010). The role of logistics manager has its origin in the military. The aim was to create a centralised organisation containing a team of experts with overall responsibility for transporting supplies and contracts with suppliers. From this, the role has evolved and today the logistics manager is responsible for developing a strategy for the logistical execution of the project and coordinating the work during execution (Sullivan et al., 2010). It is important that this person is aware of the conditions at and around the project site and the limitations that influence the project. A logistics manager should be capable of communicating with people at all levels and roles in the organisation. Further, the

logistics manager should receive information regarding the progress of the project by attending different meetings. A successful logistics manager has the possibility to help the company in achieving its strategic objectives (Sullivan et al., 2010). Using a logistics manager requires more planning from the management team, however, the result can be an increased utilisation rate of machines and elevators, less material waste due to better order on the construction site, and improved efficiency among construction workers as they could focus more on production and less on material handling (Ingemansson Havenvid, Hulthén, Linné, & Sundquist, 2016).

2.4.1.3 Waste in Construction

Apart from planning the logistics and tracing the materials to the construction site, it is important to organise and plan for the waste that will be transported away from the site. A reasonable description of waste would be something like a non-virgin material that can not be used anymore (Sullivan et al., 2010). But the truth is, the construction industry suffers from ordering too much material which means that even virgin unused material in its original packaging also can become waste at the end of a project. It is argued that reusing materials would be the most favourable solution (Sullivan et al., 2010). However, there are several challenges to reuse materials, much of the material is customised and warranties do not apply. Additionally, it is argued that the costs to find a suitable project and deliver the material to the new site overruns the costs of sending it as waste (Sullivan et al., 2010). The construction sector generates 40% of the total waste production in Sweden (Boverket, 2023a). For a project, the costs for managing the waste can represent 30-35% of the total production costs (Ekeskär & Rudberg, 2016). Sullivan et al. (2010) argue that more attention in the construction sector should be paid to SCM and logistics management to reduce the production of waste. Managing logistics of the transportation of waste away from the site can also reduce the number of transports, in a Swedish development area did coordinated waste management result in a 50-60% reduction of transportation (Boverket, 2020b).

2.4.2 Lean Construction Management

Lean construction concerns creating value for the customer while minimising the production of waste, it was first developed by Toyota and has widely been adopted and developed in the manufacturing industry (Howell, 1999). Due to the differences between manufacturing and construction the adoption in the construction industry has met resistance. The construction sector has therefore tried to adopt some of the parts of the lean concept (Howell, 1999). Within construction, lean is about management, broadly speaking, planning and control (Howell, 1999). The planning process is about creating the right conditions to ensure workflow and create predictability for the next team within the construction chain. The planning process begins already in the design phase and affects the project plan and look ahead plan, the result of the thoughtfully executed planning process results in increased control, which is the

second part of lean construction (Howell, 1999). In addition to management through planning and control, Salem, Solomon, Genaidy, and Minkarah (2006) describe that methods like just-in-time (JIT), continuous improvement, avoiding rework, reacting to change, and effective relationships within the supply chain are important factors for lean construction.

JIT deliveries have their origin in the manufacturing industry, the aim of this approach is to deliver the right material, in the correct amount, and the required quality when it is needed in production (Bamana, Lehoux, & Cloutier, 2019). Within the concept of lean, inventories are seen as non-value, and in that sense as waste (Salem et al., 2006), therefore, the material should be delivered only when needed in the production. The reason is to reduce the amount of waste and on-site storage and instead create value (Bamana et al., 2019). By implementing JIT deliveries in a construction project the opportunity is created to reduce the risk of damaging materials, decrease the need for warehouse space and facilitate for construction workers to focus more on value-adding activities, it is estimated that JIT can possibly reduce costs of material and manpower by 15% (Sullivan et al., 2010).

2.5 Construction Logistics Setups

As mentioned in section 2.3.2 Requirements, the client has the position to put requirements regarding the project, these requirements can also apply to the logistics setup of the project. A CLS can vary from small initiatives such as lean which is described above in section 2.4.2 to larger setups such as the use of a construction consolidation centre (Janné, 2020). According to Janné (2020), the use of CLSs is still seldom applied in projects, specifically, CLSs where several projects are affected by the same solution. In this section, different logistics setups will be described to get a deeper understanding of what is meant.

2.5.1 Construction Consolidation Centre

The concept of a CCC, also known as a construction logistics centre (CLC), is to store material for a short time and then distribute it to one or several construction projects (Muerza & Guerlain, 2021). Generally, the idea is that it should be a short-term warehouse where materials are to be co-loaded relatively quickly and then taken on to the construction site (Sullivan et al., 2010). In addition, a CCC can be used for other value-adding activities such as mock-up space, assembling, kitting, quality control, and reverse logistics (Muerza & Guerlain, 2021). The location of the consolidation centre is important, preferably, it should be located close to a motorway or railway to facility deliveries and at the same time it should be close enough to the construction site, a maximum of 10km, to be able to get the material there easily (Sullivan et al., 2010). CCCs are often used when the construction site is located in dense urban areas, therefore it becomes expensive to rent warehouses close

to the site, hence, there is a balance between having easy access from motorways, being relatively close to the site, but not too close since that might be too costly.

Some of the ways that a CCC can facilitate construction logistics mentioned by Sullivan et al. (2010) are; it can through co-loading reduce the number of deliveries to the site, give the option to deliver to the site after regular working hours when there is less congestion and give more control regarding deliveries. The use of a CCC enables JIT deliveries which means that the exact right amount of material can be delivered to the site to avoid material getting damaged. Due to the off-site storage and the JIT deliveries, the material does not need to be stored or moved around on-site. Using a CCC can improve the control and planning of deliveries, which can improve the workflow for construction workers, meaning that they can focus on value-adding activities instead of getting disturbed by receiving deliveries and spending time waiting. Furthermore, the CCC creates a buffer which decreases the risk of increased lead times and improves the logistics mindset in the supply chain. Furthermore, Muerza and Guerlain (2021) mention that using a CCC has the potential to improve all three aspects of sustainability. The environmental aspects are several, for example, reduction of CO_2 -emissions, less congestion and noise pollution, and less waste. The social benefits is improved working environment from improved workflow, fewer vehicles on site, and less material handling. Social benefits can also be found outside the construction site due to less congestion, reduced number of safety risks, less noise, and improved air quality (Guerlain et al., 2019). There is a possibility to achieve economic benefits from using a CCC due to improved transport planning (Guerlain et al., 2019). According to Muerza and Guerlain (2021) using a CCC can result in more efficient logistics processes. Muerza and Guerlain (2021) imply that several incentives have failed to make the CCC financially defensive. Despite this, if several construction projects can operate in the same CCC, costs can be shared and costs can therefore be reduced. To maximise the positive effects of using a CCC an evaluation process, examining whether a CCC is a suitable solution or not should be carried out at the planning stage of the project (Muerza & Guerlain, 2021).

2.5.2 Checkpoints

To increase control on the construction site checkpoints can be used to allocate deliveries (Janné, 2020). Checkpoints is a CLS where all deliveries are aimed to arrive just in time and are booked through a system where information regarding the type of material, vehicle type, volume, and unloading equipment is specified. The aim of this type of CLS is to plan deliveries in a way that they are spread out throughout the day. This creates a flow of material deliveries and optimises the usage of unloading equipment. By planning deliveries, the risk of congestion on site is reduced, hence, the risk of accidents. Further, this CLS reduces the impact on third parties as it results in less congestion outside the construction. Despite this, there is a risk that deliveries instead wait further away from the construction site (Janné, 2020). In a case study performed by Ekeskär and Rudberg (2016) this problem was avoided since the driver contacted the checkpoint personnel 30 minutes

before their arrival if there was a queue at the site, they were asked to stop at a gas station and wait. Hence, Akintoye (1995), implies that when implementing JIT it is important that contractors and suppliers at all levels are aware of the working procedure and the JIT concept to fulfil the potential of JIT. Furthermore, using a checkpoint requires more planning from suppliers and contractors in order to work (Janné, 2020). If the purpose of the CLS is to reduce the number of transports and control when deliveries arrive, a nearby CCC can be used in combination with the checkpoint to consolidate deliveries and later reduce disturbances on and nearby the construction site (Janné, 2020).

2.5.3 Third-party Logistics

A third-party logistics (TPL) contractor provides management and logistics operations for all or part of the logistics operations, a TPL provider can be used in different industries and many TPL providers offers a wide range of services (Ekeskär & Rudberg, 2016). The most common TPL services are transportation and storage, in addition to this can many TPL providers help with material handling, repackaging, installation of products, tracking and tracing deliveries, distribution planning and managing the supply chain. To improve efficiency, many TPL providers offer to bring in materials after regular working hours. In this way can unloading equipment and elevators be used without disturbing the workers during the days (Ekeskär & Rudberg, 2016).

Logistics solutions can sometimes be met with scepticism because they are otherwise hidden, costs become visible with logistics solutions and it can be difficult to put a monetary value on the benefits (Janné & Rudberg, 2022). The result of employing a TPL contractor is that otherwise hidden costs become visible. In the article by Ekeskär and Rudberg (2016) it was revealed that in the projects within their research that outsourced logistics work to a TPL provider had lower total costs compared to their reference project, even if the logistics solution added some costs. According to Janné (2022), the benefit of employing a TPL contractor is that the construction workers can focus on value-adding activities, this solution can in that sense contribute to creating a workflow, which also creates an opportunity for new expertise to be developed.

2.5.4 Information and Communication Technology

As described by Lambert and Cooper (2000) logistics is about planning, implementing, and controlling an efficient and effective flow of materials from the point of origin to the point of consumption. As mentioned earlier less than 40% of deliveries to construction sites arrive according to the order and without damages (Ekeskär & Rudberg, 2016). In addition, the construction sector has been slow to adapt to new technologies (Dubois et al., 2019). Generally, it is difficult to track materials in the construction sector which results in poor control and inefficiencies in material flow (Fadiya, Georgakis, Chinyio, & Nwagboso, 2015). Delivering materials far in

advance increases the risk of them being lost, damaged or stolen. Further, this leads to material waste, delays in deliveries, and extra costs. Therefore, it is important to be able to follow materials in real-time and thus have control over material flows (Fadiya et al., 2015). Janné (2020) describes information communication technology (ICT) as a system where actors within a project can have role-based access to information for planning, booking, tracking, tracing, and carrying out returns. In some projects are all material deliveries planned and called off in the system (Janné & Rudberg, 2022). Janné (2020) claims that planning, coordination, execution, and controlling of logistics flows and on site-operations with ICT is essential no matter which CLS is used, as an ICT system can make construction projects more efficient.

2.6 Measuring Logistics Performance in Construction

In section 2.3.2 Requirements, it was described what clients should keep in mind when placing requirements. One of the conclusions was that they needed to be able to control that the requirements are fulfilled. Further, measuring logistics enables possibilities to enhance the logistics solution and its performance of it as metrics can highlight where inefficiencies arise (Ying, Tookey, & Seadon, 2018; Janné, 2020). Janné (2020) claim that different metrics suits different stakeholders depending on their interests and what they value most. In addition, it should be decided at an early stage which metrics will be used to clarify the expectations of the project (Janné, 2020).

Ying et al. (2018) mean that there are several aspects that need consideration when choosing metrics. Firstly, the number of metrics chosen to be examined needs to be selected wisely as too many or too complex metrics will take time and resources. Secondly, the data should be easily collected and thirdly, the metrics should be able to convert praxis to measurable and comparable numbers. Ying et al. (Ying et al., 2018) carried out a case study regarding vehicle movements. The conducted data was used to identify delivery patterns such as peak time of deliveries. With this knowledge, deliveries can be scheduled outside this time frame to avoid waiting time which results in improved on-site logistics (Ying et al., 2018). Data is used to analysing the effect of various solutions while evaluating whether the solutions have produced the desired effect (CIVIC, 2018).

Both Janné (2020) and the CIVIC handbook (2018) suggest different measurements to analyse logistics performance, some of the common ones they mention are the number of deliveries that are on time in relation to the total number of deliveries, number of movements of materials on site, waiting time, and fill rate of deliveries.

Ying et al. (2018) argue that the costs connected to logistics are ignored in the industry. Collecting data can be used to benchmark the current state of logistics performance and provide a starting point for improving construction logistics. Furthermore, metrics can give insights into underlying reasons for performance (Ying

et al., 2018; Janné, 2020). For example, Janné (2020) claim that a lot of movements of material can indicate that the material has been ordered too early.

2.7 Sustainable Development in Construction Logistics

As early as 1987, with the release of the Brundtland Report, the United Nations recognised the correlation between economic development and ecologic degradation (World Commission on Environment and Development, 1987). Even then, one could observe the impact of the rapid development of society in terms of technology, transportation, and mass production on the earth and its resources. It was within this same report that the concept of sustainable development was formulated by World Commission on Environment and Development (1987) with the following definition

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

(p.41)

Sustainability covers three aspects: environmental, economic and social. All of which can be correlated to construction logistics. According to Kordi, Belayutham, and Che Ibrahim (2021) environmental sustainability can be connected to reduced greenhouse gas emissions, economic sustainability can be optimising life cycle economic performance, and social sustainability can be about ensuring comfort and health, and creating job opportunities. In order to develop a sustainable construction industry, none of the three aspects can be neglected. Kordi et al. (2021) argue that social sustainability often becomes ignored, which can result in poor security and health. They mean that by featuring social sustainability health and safety can be improved and interference to third parties can be reduced.

By 2045, Sweden should have net zero emissions, and thereafter, Sweden should reach negative emissions (Sveriges miljömål, 2023). To reach the targets for 2045, nine Swedish cities have been selected, including Stockholm, Göteborg, and Malmö, to test innovative solutions to achieve the net zero emissions targets already by 2030. The aim is that these cities should set an example for other cities in the country to reach the targets for 2045 (Göteborgs Stad, n.d.). Meanwhile, the construction sector represents 21% of Swedish CO_2 -emissions and 40% of the waste production (Boverket, 2023a; Regeringsbeslut Fi2022/00506, 2022). Globally, the carbon emissions from the construction sector is 39% (Circularity Gap Reporting Initiative, 2022).

In Sweden, one of the largest contributors to CO_2 -emissions is transports (Sveriges miljömål, 2023). A large share of these transports are connected to the construction sector. In cities, 50% of all heavy transports are connected to the construction

sector and within the country is 20% of all transports connected to the construction sector, consequently, construction represents the major part of CO_2 -emissions from heavy transports (Abrahamsson et al., 2019). Consequently, a separate target for transportation has been set for 2030. The aim is to reduce emissions from transportation by 70% by 2030 compared to 2010 (Sveriges miljömål, 2023). Reduced transportation can improve all three aspects of sustainability. Besides the environmental benefits, a reduced amount of transport can result in improved social sustainability as less transport means less interference in the form of congestion, a reduced number of safety risks, less noise, and improved air quality due to less pollution (Guerlain et al., 2019). Further, there is an economic benefit that could be. Even though fewer transports could be achieved by construction logistics Guerlain et al. (2019) argue that logistics is a secondary issue in the sector. Section 2.5.1 Construction Consolidation Centre describes deeper how a CCC can be used to reduce the number of transports.

Several studies shows that production costs can be decreased due to more sustainable construction. Dubois and Hulthén (2002) claim that the total construction costs can be reduced by 20% if the transport and logistics solution is well planned. As mentioned in section 2.1 Overview of the Construction Industry less than 40% of the deliveries to construction sites arrives according to the order and without damages (Ekeskär & Rudberg, 2016). In a case study performed by Agapiou (1998) the total cost savings was calculated to 5% due to a reduction of material waste and breakages and early completion of the project.

3

Methodology

This chapter presents the working process and arguments for the choice of method to achieve a valid result and answers to the selected research questions. Firstly, the data collection process is described, followed by a discussion about the ethical considerations, trustworthiness, and limitation of the method.

According to Burnard et al. (2008) there are two main approaches that can be applied when analysing qualitative data. Either can an inductive or a deductive approach be used. In this thesis, an inductive approach has been selected. According to Burnard et al. (2008) the inductive approach is the most frequently used method in qualitative studies. The inductive approach implies that the interviewer does not have a predetermined theory about the interviewee's answer in the data collection process (Burnard et al., 2008; Bell, Bryman, & Harley, 2022). When collecting data in the form of words, it is called qualitative research (Bell et al., 2022). The qualitative research approach aims to understand, describe, and explain phenomena from different points of view and subsequently interpret the data (Flick, 2018).

3.1 Data Collection

As mentioned above, this thesis has a qualitative research approach which can be gathered in different ways, for example, by talking, listening, observing, analysing sounds, pictures, or digital concepts, or a combination of the mentioned ways (Flick, 2018). Depending on what is to be achieved with the research, different data collection methods are suitable. In this master thesis have interviews been chosen as the method to gather data. Interviews are suitable when the aim is to gather different perspectives. If the aim was to analyse different behaviours, it could be an argument to use observations as a method instead (Flick, 2018). As this master thesis aims to gather data regarding property owners' work with construction logistics, therefore, interviews became the selected method to be used.

3.1.1 Interview Process

Qualitative data was collected through semi-structured interviews. The interviews were carried out with individuals representing various property owner organisations, alongside personnel from contractors, logistics suppliers, urban developers, and academic institutions. A list of questions was prepared and divided into three categories, namely, construction logistics, requirements, and sustainability. The purpose of dividing the questions into different categories was to make the structure clear to the interviewee, but also for our own sake to be sure that the research questions could be answered. Small changes in the questions were made to suit the current interviewee. The questions had an open-ended character that ended up with a wide range of answers, and depending on the response, different follow-up questions were asked. Since the interviews had a semi-structured character the follow-up questions differed between the interviews.

To create a candid picture of how property owners work with construction logistics right now and how they could work with it in the future, contractors and logistics firms were interviewed in addition to property owners, even if the property owners were the main focus and represented the largest part of the interviewees. The main criteria in the selection of property owners were that they should work with developing new construction projects in dense areas in the largest cities in Sweden. In addition, urban developers were interviewed, who work in development areas and have the authority to govern property owners that will operate in their developing areas. Working specifically with construction logistics was not one of the selection criteria. The contractors were interviewed to answer questions about how they would prefer that property owners work with construction logistics, the same goes for the logistics suppliers.

In table 3.1 and 3.2 are the thirteen interviews described with a label, the profession of the respondent, type of interview, duration of the interview, and company name. The labels describe whether it is a property owner (P), contractor (C), urban developer (U), logistic supplier (L), or academia (A). These labels will be referred to in the results and discussion chapters of the thesis. The labels that end with a letter indicate that two people from the same organisation participated in the interview. In total, there were two interviews participated at the same time. The interviews were held either physically in the interviewees' office or digitally. Each interview began by checking if it was okay to record the meeting. The recordings were later transcribed, the interviews were held in Swedish and the citations have been translated to English by the authors of this master thesis. The length of the interviews varied between 35 minutes to 1 hour and 15 minutes. To minimise the risk of misunderstandings, both authors of the master thesis attended all interviews.

Table 3.1: List of interviewees.

Label	Profession	Interview type	Duration
P1.A	Business area manager	Physical	35 min
P1.B	Project leader	Digital	35 min
P2	Project developer	Digital	35 min
P3	Project manager	Digital	40 min
P4	Project leader	Physical	60 min
P5	Project leader	Physical	60 min
P6	Logistics manager	Digital	45 min
C1	Project manager	Physical	55 min
C2.A	Logistics planner	Physical	70 min
C2.B	Logistics coordinator	Physical	70 min
U1	Project leader	Physical	35 min
U2	Innovation leader	Digital	75 min
L1	Sales marketing manager	Digital	55 min
L2	CEO	Physical	60 min
A1	Assistant professor	Digital	60 min

Table 3.2: List of interviewed companies.

Company	Role in sector
Balder	Property owner
Castellum	Property owner
Exploateringsförvaltningen Göteborg	Urban developer
Hufvudstaden	Property owner
Jernhusen	Property owner
JM	Property owner
Linköpings Universitet	Academia
Myloc	Logistics supplier
NCC	Contractor
Svensk Bygglogistik	Logistics supplier
Vasakronan	Property owner
Älvstranden utveckling	Urban developer

3.1.2 Analysis of Data

Thematic content analysis is the most common method when analysing qualitative data gathered from interviews (Burnard et al., 2008; Bell et al., 2022) and was the data analysis method selected in this thesis. In contrast to quantitative research, the data analysis in qualitative research can begin as soon as the first data are collected and continues throughout the study. The process began with reading through transcripts and making notes and highlights. The second step was to collect the notes and remove duplication. After a first analysis of the collected data, it was possible to find gaps that need clarification or further investigation. The resulting notes were then moved around into different overlapping categories to reduce the number of categories. This process was performed for all interviews to make an order of the qualitative data and find patterns between the results. This was performed according to the description by Burnard et al. regarding thematic content analysis (2008).

3.2 Ethical Considerations

When conducting data, there is always a risk for ethical issues to appear, the first step to avoid the issues is to be aware of the problems. According to Bell et al. (2022) there are four main ethical principles to take into consideration. The first principle aims to avoid harm to participants, Bell et al. (2022) describe that harm can be different kinds of things, physical, harm to the respondents' self-esteem, stress, and harm to career prospects or future employment. The second principle that is described is the absence of informed approval, which means that the respondents need as much information about the work as is necessary to make an informed decision about whether it is appropriate for the person to participate or not, this principle also implies that the respondent should be informed if the meeting is recorded. The third principle mentioned by Bell et al. (2022) considers the privacy of the respondent which is linked to the second principle of making informed consent, since, participating in a study in some ways intrudes on the private sphere. It can be difficult to know in advance which questions can be sensitive for the respondent. The fourth principle considers whether deception is involved, which can occur if the data is used for something else than what is said.

To avoid these four ethical problems, information about the work was sent to respondents in advance before they agreed to be interviewed. Each interview began by checking that it was okay to record it. As a second question, all respondents were asked if it was okay to mention their company name and their job role in the thesis, which was okay for all interviewees. To keep the anonymity of the interviewees, they have been coded instead of using their company names in the thesis. Further, the respondents were told that it was okay to avoid answering the questions if they felt uncomfortable doing so.

3.3 Trustworthiness

Bell et al. (2022) argue that qualitative and quantitative research should be assessed in different ways. As this is a qualitative study, trustworthiness is of greater importance than reliability and validity which usually is used to assess quantitative studies (Bell et al., 2022). Trustworthiness is an important concept, as this defines whether the research is worth the attention of other stakeholders in the industry and the wider public. The aim of trustworthiness is to convince the reader that the research is credible (Nowell, Norris, White, & Moules, 2017). Guba and Lincoln (1982) have defined four terms to determine whether something is trustworthy, the concept includes credibility, transferability, dependability, and confirmability.

To provide credibility to the research, meaning that it is reliable, the process has been monitored by the supervisors from Chalmers and Afry. Additionally, two other students reviewed the thesis two times, firstly in the middle of the progress and lastly in the concluding phase. External checking was one of several suggested approaches to prove credibility according to Guba and Lincoln (1982).

The second term, described by Guba and Lincoln (1982) was transferability. This is connected to the application of the study which means that the content of the thesis first and foremost should represent the general opinion in the group it is addressed and it should be described sufficiently enough. This is to ensure that other researchers can determine whether it is transferable for their studies or not. However, as a researcher, it is not possible to know how other people want to transmit the results (Nowell et al., 2017). By interviewing representatives from the largest property owner companies in Sweden, it can be argued that a generalised perspective is possible to make. The results have been presented in combination with clear examples to give the reader sufficient information to determine whether or not the result is transferable to their context.

The third term described by Guba and Lincoln (1982) was dependability. To prove dependability, the research process should be coherent, traceable, and properly documented. Nowell et al. (2017) argue that dependability can be achieved if the reader can follow the development of the study. To enable readers of the study to assess the dependability, the used method has been described earlier in this chapter. Additionally, the process has been carried out in close cooperation with the supervisors to ensure a coherent result.

The fourth and last term confirmability is achieved when the other three terms are met (Nowell et al., 2017). Confirmability states that the conclusions made in the study have been derived from the collected data, this requires that the author validate how findings have been attained (Nowell et al., 2017). Confirmability has been addressed by recording the interviews and thereafter transcribing the interviews. The recordings have been listened to again if there have been unclarities in the transcriptions. In the discussion part of the thesis findings from the interviews have been compared with the theoretical framework to illustrate similarities and inequalities.

In addition to trustworthiness, Bell et al. (Bell et al., 2022) argue that the authenticity of the research should be evaluated to confirm that the researcher has not placed any personal impact due to social or political standing. Authenticity is also analysed to confirm that the research presents a fair picture of the general opinion within the studied area (Bell et al., 2022). In this master thesis, the property owners were selected with the primary requirement that they should work with the development of properties to enable a generalised picture of the property owner's view on construction logistics. However, all interviewees could not answer all questions due to limited knowledge of construction logistics and procurement. To improve the result, meaning that all interviewees could answer all questions, it could have been relevant to interview several people from the same company. Primarily, the questions regarding formulations of requirements were the most difficult ones to answer.

3.3.1 Discussion of Methodology

This section aims to discuss the limitations of the methodology. The interview questions in this study were of an open-ended nature, which means that the interviewees were not given any alternative answers to the questions. Nor did they receive any information from the authors of this thesis about what construction logistics could mean or lead to. In this way, the answers were limited to what the interviewees knew about the subject at the time of the interview. In a way, this shows the current situation in the industry. On the other hand, some interviewees had a fairly narrow view of what construction logistics could entail, as some interviews were focused solely on transport as a way of working with construction logistics. Another note that was made was that many respondents had difficulty seeing the link between construction logistics and social sustainability and therefore could not give examples of how it could be a driving force for them. However, they were curious and wondered what connection the authors of the thesis saw, and when given some information they agreed. These answers are not included in the study, but it shows that the property owners would have seen more benefits from construction logistics if they had more information on the subject. It is shown that the open nature of the interview questions leads to limitations, however, these show the current state of knowledge in the industry, which is what the authors wanted to investigate. Since there is no specific professional role among property owners who work with construction logistics, it could be beneficial to interview several people within the same organisation to get answers to all questions.

More specific questions could help to determine whether or not property owners actually work with construction logistics. Although many of them considered that they were working with construction logistics, the open nature of the questions has shown that the property owners consider that they are working with construction logistics from their perspective. This is not necessarily the case; if it had been more clearly defined what is required to say that a property owner is engaged in construction logistics, we would have been able to determine whether the property owners are working with construction logistics or not.

4

Result

This chapter presents and analyse the result gathered from the interviews. Section 3.1.1 Interview Process presents information regarding how the interviews were conducted and the persons interviewed, showing that property owners, urban developers, contractors, logistics suppliers, and academia have been interviewed with a wide spread of different roles. The interviews have been analysed in such a way that the similarities and differences of the interviewees' answers have been identified and then presented in this section.

The chapter starts by describing how property owners work with construction logistics today. Followed by a section describing the driving forces for property owners to work with construction logistics. This section also describes how property owners believe that they can improve their sustainability performance if they had worked with construction logistics. The last part of this chapter analyses possible ways of working with construction logistics in the future.

4.1 The Current Role of Property Owners in Construction Logistics

How and if property owners in the sector work with construction logistics vary. This is evident as the interviewees have answered differently on how and if they work with construction logistics. Five of six property owners state that they work with construction logistics in some way. One of these, P1.A, considers it as a prerequisite given the central location of their projects. Two of the property owners state that they work with construction logistics indirectly. One means that it is included in requirements for sustainability and the other includes construction logistics by planning the flow of third parties passing through their construction projects. The property owner who does not work with construction logistics is straightforward about the fact that they are clients and therefore leaves the responsibility for logistics to the contractor for each individual project.

All except the property owners, state that the property owners bear too little or no responsibility for the construction logistics in building projects. In addition, the contractors claimed that it was unusual that property owners work with construction logistics or that they did not notice that the property owners worked with it. In

general, the sector considers the contractor to be responsible for the logistics and one of the logistics suppliers believes that property owners protect themselves by not interfering in the logistics of the project. However, it can be seen that this is partly changing as the interest in construction logistics is gradually increasing, especially among property owners with projects that have significant logistical challenges.

Pricing of Construction Logistics

Today logistics is not priced separately in procurement instead it is included in the pricing of other works. According to A1, there are therefore problems in measuring the economics of construction logistics. The interviewee believes that the logistics costs are not visible to the eye, neither for the property owner nor the contractor, as they are included in the price from the material suppliers. Then, there are logistics costs arising on the project for construction workers from waiting time, unloading of materials, moving of materials, and handling of materials which is activities that do not drive the projects forward. All of these reasons affect hidden construction costs and the productivity of the project. The invisible costs may be extremely high, especially in large projects. The interviewees argued that if a construction logistics solution is not included in the tender documents, it is difficult to include it at a later stage as there is no budget allocated for it. Interviewee A1 claims that the role of suppliers in the logistics chain is also mentioned as a barrier to development. Since suppliers work with fast deliveries and it is possible for contractors to order materials the same or the day before delivery. The possibility of fast deliveries is something that the suppliers take very good payment for, a cost that later ends up on the property owner.

Logistics Analysis

Conducting a logistics analysis before a project starts is considered a good way to evaluate which solution(s) should be used during the project. This is something that has been done by one of the property owners interviewed, however, the usual practice is to leave the responsibility to the contractor without investigating the logistical feasibility of the project. One of the urban developers has developed a logistics strategy, which has not yet been used, in the future it will be a requirement to include this in the projects where they sell land allocation.

Construction Logistics Setups

Contractors have a much clearer understanding of how they work with construction logistics than property owners. Setups such as CCC, JIT-deliveries and TPL providers are mentioned by the interviewees working as contractors. The choice of setup depends on the project and the phase of the project. Two property owners have their own consolidation centre where they store material between projects or when a building is reconstructed, thus this can not be used by the contractor for material handling but is good for enabling circularity of materials.

Interviewee P6 believes that short lead times are essential to make projects more efficient and thus save money. They see it as necessary to work in all parts of the building all the time. The interviewee draws parallels to the automotive industry where there is always something in progress in every car, therefore something should always be in progress in every apartment as well. They also try to ensure that the

same person performs repetitive tasks, such as assembling the kitchen, to improve efficiency. CCCs are used for short-term storage and co-loading trucks with a high fill rate are used for deliveries in projects in dense areas. The material flow is the responsibility of the material planner who reacts to deviations such as destroyed material, delays of material from the supplier, or re-planning of material due to changes in the project's time schedule. A material planner is a central role in the contractor organisation, which monitors the entire flow. The material planner also manages the call-off of materials. When the material is delivered, third-party logisticians from the company handle the material. The third-party logisticians carry materials after regular working hours to the designated location. Interviewee P6 states that:

A surgeon does not run around looking for a needle and thread in the storeroom in the middle of an operation but rather gets it by just reaching out a hand. That's how it should be for a craftsman too. Then I think it will be efficient.

- P6

Knowledge Transfer

Another finding when analysing the current state was that knowledge transfer in companies is low and not an active process. There is a lack of learning from previous projects and many actors often do what they have always done. Interviewee P4, mentions this as a general problem in the sector and says that if the employees sat down and went through what went well and what went bad in the projects and worked on developing those aspects for the next project, it would be good for the company and the sector. However, this is not something that is often done, and on the occasions when the process is started, it is usually not finalised. Three out of eight property owners, including urban developers, have learnt from previous projects when it comes to construction logistics. Those who have not learnt do not consider that they have worked sufficiently with construction logistics to learn anything or they do not consider that they need to learn anything. One of the companies that have learnt from previous projects has made several different attempts to improve its work with construction logistics, where the attempts have been more or less successful from a sustainability perspective. The second company has learnt the following lesson:

There is no such thing as a too-early dialogue with relevant stakeholders

- P1.A

Requirements

As a part of describing how property owners work with construction logistics today, the interviewees were asked to describe how they put requirements on construction logistics. According to one of the logistics suppliers, it is most common that large urban development projects or hospital projects put requirements on construction logistics. Regarding the property owners, it has already been described that one of

them put requirements by giving the prerequisites for the project. They can provide requirements regarding which times it is allowed to deliver material, the maximum weight of transports, what times of the day it is permitted to carry out disruptive work, or where materials may be unloaded.

Another aspect was that the property owners seemed to agree that form of contract did not affect their approach to construction logistics, regardless of whether the interviewee was in favour of setting requirements or not. Interviewee P1.A adds that in large projects, requirements are put in the administrative regulations part of the contract, however, it is often in general terms saying that the contractor is responsible for the coordination with the city and obtaining the necessary authorisations. The responsibility of construction logistics is something they overwrite to the contractor in the contracts. Another interviewee mentioned that they make requirements on waste and sorting, and in some projects, make requirements on minimising the impact on third parties. These requirements can specify which hours of the day the materials can be received.

The logistics supplier, L1, believes that if construction logistics are included in the conditions and taken into account in the procurement of contractors and suppliers, it creates opportunities and reduces the number of risks in the project. This is justified by one of the urban developers. Neither of the two urban developers had put requirements on construction logistics in previous projects. However, one of them had raised the subject in one project, but it was a little late, money had not been allocated at an early stage, and the contractors replied that they could manage to solve the logistics on their own. These reasons led to the cancellation of the plans of reaching a joint logistics solution.

Monitoring of Requirements

On the question of how the requirements are monitored and followed up, the interviewees answered that no special metrics are used, contractor C2.A, answers:

If it works, it's good. In other sectors, such as the automotive industry, people are not satisfied just because it works. It works, but at what cost?

- C2.A

The general feeling is that for as long as no one complains, everything is fine. One of the property owners confirms this by saying that requirements are followed up by themselves, if they are not followed, tenants will complain. Another property owner seems to have a similar approach, they answered that requirements are monitored by controlling whether the time schedule or budget is followed or not. Another interviewee argues that clients could be more knowledgeable in this area, take a more active stance in the execution of a project and make requirements that projects should be executed in an effective way. The same interviewee continues to argue that property owners do not seem to fully understand that construction logistics can contribute to more productive projects and ultimately, save money.

4.2 Driving Forces for Property Owners

In order to gain an understanding of the drivers for property owners to work with construction logistics, the interviews included questions on whether the interviewees could see any benefits of construction logistics and what potential construction logistics could have for property owners. In this section, the driving forces will be described in more detail and specific examples of how construction logistics can affect these driving forces according to the interviewees.

Reduce Production Costs

All except one of the interviewed property owners described reducing costs as a driving force to work with construction logistics. Two of the property owners answered that since they are the ones who pay in the end, it is in the interest of the client to reduce the expenses. The property owner P1.A expresses the driver of using construction logistics as:

If the contractor can reduce their costs, this will lead to a reduction in our expenditure, as we are the ones who pay in the end. If you don't think about streamlining construction logistics, projects risk being longer. Therefore, there is every incentive in the world to make construction logistics as efficient as possible.

- P1.A

The responses on how production costs could be reduced by using construction logistics varied. Reducing the number of transports was mentioned by several interviewees and the result of this can among other things be reduced costs. Interviewee P4 argued that it will cost money if they do not have construction logistics that work as it will result in the production of waste of material, less resource utilisation, and a poor working environment. Interviewee P6 focuses on shorter lead times since if they can reduce construction time, costs in the form of rental costs for equipment, cranes, scaffoldings and such decrease as well as tenants can move in earlier which generates money. Furthermore, P6 described a project where they had considered the construction logistics already during the design. Thus, they could adapt the design to reduce costs and increase customer satisfaction. If the design had not been adopted, the material would have had to be spliced or require special cranes to bring in the material. Instead, a different material with other dimensions that fit into the construction hoist was chosen, avoiding expensive crane costs and providing an attractive solution.

Interviewee P5 described another aspect of construction logistics that could be connected to reduced production costs. According to the interviewee, an orderly construction site usually means that the schedule is kept, costs are kept and quality is met. Interviewee P3 mentioned that planning and optimising the delivery of material can result in a reduced number of transports which can result in decreased production costs. Lastly, the urban developer U2 emphasized the socio-economic benefits as the main driver for focusing on construction logistics and more specif-

ically reducing the number of transports in cities through co-loading or ordering deliveries outside peak hours of congestion in cities.

Minimise Impact on Surrounding Business

As a property owner, it is important with satisfied tenants and to enable businesses to run. One interviewee mentioned that to a certain extent, tenants need to be aware that cities are developing and that construction will take place, but of course, you want to minimise the impact on their business. Therefore the logistics around the construction site need to be planned so that these impacts are reduced. Another property owner mention that construction can change the flow of people moving through their buildings, therefore, the construction logistics and temporary pedestrian routes need to be planned so that people do not choose alternative routes and thus do not come back as customers in their buildings. In some areas, tenants will move in on some floors meanwhile construction proceeds in the rest of the building. In these cases, it is important for the property owner to have well-thought-out construction logistics to minimise conflicts between tenants and construction. Another driver to work with construction logistics that was mentioned is to reduce the number of complaints from third parties.

Minimise the Risk of Delay

Another incentive to work with construction logistics is the time aspect. The risk of delay can appear due to bad construction logistics, lack of planning, and unforeseeable production. Furthermore, delays can be tightly correlated with increased costs. For property owners, there is an interest in finishing projects on time as they bring in money through rent. Due to this, minimising the risk of delay is mentioned by several of the interviewees. All contractors and logistics suppliers mentioned the time aspect as a driving force to work with construction logistics. The property owner P1.A, has a project in a dense area and argues that their entire time schedule in the project is largely governed by construction logistics, as their logistics conditions mean that all deliveries must arrive fully loaded and on schedule.

Further, the time aspect can be connected to productivity in the execution of the project. This aspect was also mainly highlighted by the contractors but also interviewee A1 mentioned this. Construction logistics improve planning which can reduce the number of surprises during construction, making the process more predictable and thus reducing the risk of unexpected events leading to delays. The logistics supplier L1 describes that there is a strong correlation between planning and the number of disruptions. Interviewee P5 and P6 mentions that productivity can be increased by creating a workflow. A better workflow can be achieved by various logistics measures. Interviewee C1 mean that taking buildability into account in the design process can simplify both the working environment and the progress of the project. JIT deliveries reduce the need to search for materials, in addition, it reduces the behaviour of ordering duplicates, which is otherwise common in the construction industry according to interviewees C1, C2.A, and L1. Either, the material was delivered too early and thus lost, another reason could be that the supervisor is not aware that it has been delivered, or poor organisation at the workplace which makes it easier to order the material again instead of looking for the material. Interviewee P6, argues that continuous improvement is another way of shortening the

time, in housing projects the same step is often repeated several times, the first time takes longer than the following times. Some projects bring in a TPL company to bring in materials after regular working hours, which allows workers to focus on value-adding work instead of being interrupted during the day to receive deliveries, unload, and transport materials. Employing a TPL company to bring in material saves time according to interviewee P6. Interviewee A1, claims that the benefit of setting requirements for construction logistics has improved productivity, which can result in two things: lower production costs or an earlier completion of the project, which means that the property owner can let the property earlier.

4.2.1 Sustainability in Construction Logistics

All interviewees were asked to give examples of how construction logistics could contribute to property owners achieving their sustainability goals from all three sustainability aspects. However, several interviewees could not answer how construction logistics could contribute to social sustainability. Figure 4.1 shows the compiled result of the property owners' and urban developers' answers, in total 8 interviewees. On average, each interviewee gave 3.3 suggestions on how sustainability could contribute to their sustainability goals. The figure shows that all interviewees answered that construction logistics could contribute to minimising CO_2 -emissions.



Figure 4.1: Compilation of the property owners' and urban developers' answers on how construction logistics can help achieve their sustainability goals.

Minimise CO_2 -emissions

The six categories of answers shown in figure 4.1 are a compilation of the interviewees' answers. One of the interviewees mentioned construction logistics as a piece of the puzzle in achieving the goal of being climate neutral by 2030. Several others mentioned that minimising CO_2 -emissions was a result of working with construction logistics, with some interviewees connecting it to using less material or reducing

waste and some connected it to using eco-fuel or decreasing the number of transports. Interviewee P2 believes that reducing the number of transports is an obvious way to reduce environmental impact, yet they do not make any demands in this regard. Interviewee P5 mean that if the flow of material and the construction site layout plan is optimised, this can result in fewer movements of materials to the site and on-site which can reduce emissions.

Reduce Transports

Six out of eight property owners and urban developers mentioned reducing the number of transports as a contribution to improved sustainability. Several interviewees argued that a reduced amount of transport can result in less CO_2 -emissions as well as decreased costs. This can be realised by co-loading and planning material orders to increase the fill rate. Interviewee P1.A uses a CCC to co-load deliveries which reduces the number of last-mile transports, increases the fill rate, and reduces the total amount of deliveries. Interviewee U2 mean that transport efficiency can be improved in the future by using high-capacity transports to reduce the number of construction vehicles in cities.

Reduced amount of heavy transport can result in less impact on third parties, as it increases road safety and results in less urban congestion. The property owner P6 has through co-loading in their CCC been able to reduce their number of transports by 80%, it should be clarified that this 80% represents the transports the company generates as they do not co-load deliveries with their sub-contractors. Further, interviewee P6 points out that these trucks drive with eco-fuel to reduce CO_2 -emissions.

Improved Cost Control

Some interviewees argued that construction logistics can result in better cost control, as reducing material waste and reducing the number of transports can affect the total production cost. In addition, construction logistics can result in improved efficiency as construction workers spend more time on the right things. One interviewee agreed with this, however, the interviewee emphasised that construction logistics can increase costs on one end and reduce costs on another end. Despite the change in the distribution of costs, the interviewee argued that property owners should focus on construction logistics as it can result in improved project performance, which ultimately saves money.

Reduce Waste

The figure shows that 50% of the interviewed property owners and urban developers consider reducing waste as a driver to work with construction logistics. The interviewees mentioned that treating waste costs money, and reducing waste can be connected to both improved cost control and reduced climate impact. Reducing the amount of waste can be achieved in various ways, for example, less damaged materials, using remains of materials, and no double orders. These things can be achieved when material delivers when it is needed (JIT) and when the construction site is orderly managed so construction workers find their materials and leave the remains of materials in designated places. From the property owner's point of view, there are also incentives to reduce the amount of waste. One property owner states:

To put it bluntly, all the waste thrown into the rubbish bin is something we have paid for, and we also have to pay to transport it away as waste.

- P3

Therefore, planning for optimisation of material use will cost money in one end, but in another end could the amount of waste be reduced which will reduce both material costs, handling of the material on site, costs for transporting it away and treating it as waste.

Reduce Impact on Third Parties

Another aspect that was mentioned in several of the interviews was the responsibility of urban developers and property owners to enable businesses to run their activities while the city is developed and construction is ongoing. The urban developers want vibrant cities and the property owners want to have satisfied tenants in the surrounding buildings.

The central location of construction projects has been mentioned by several interviewees as a reason to work with construction logistics. Several of the interviewees implied that as cities become increasingly exploited, construction logistics become even more important. One interviewee, P1.A, recently planned a project in a dense area where they were already in the preparation of the detailed development plan and hired consultants to investigate if it was possible to carry out a large construction in this location. The project was surrounded by the city's main public transport hub, the city's busiest pedestrian streets, bicycle paths, hotels, and other businesses operating in the area. In this case, the property owner had strict rules to follow in order not to disturb the public transport hub while the project was ongoing. Even the ground conditions limited the possibilities for heavy construction deliveries to access the construction site. Therefore, there was a strong need to analyse logistics solutions at an early stage.

The responses from the urban developers show that it is mainly the social and ecological sustainability aspects that are their driving forces for working with construction logistics. Both interviewees clearly show that it is the city's residents and the city's environmental goals that are their focus. For example, they believe that construction logistics should be used to decrease the disturbance on third parties to encourage a vibrant city in parallel with construction execution. The consequences of less amount transports in cities are also seen as important as it reduces noise, improves air quality and increases road safety.

Interviewee P1.A, means that it is important to have a dialogue with involved stakeholders and people affected by the project to understand how the construction will actually affect these people. People living and working in a city must also expect the city to evolve, but the journey can be made as good and comfortable as possible for everyone involved. Interviewee P2 argues that well-planned construction logistics can enable businesses to operate despite the presence of a construction site nearby.

Safe Work Environment

Several interviewees speculated that a safer working environment could be a result of working with construction logistics as fewer heavy transports and orderly construction sites could possibly lead to fewer accidents. However, they did not have any data on this. Further, improved planning and focus on construction logistics could reduce stress which improves the working environment for construction workers.

4.3 Future Opportunities for Property Owners

In this section, the response from the interviews related to the future of construction logistics is presented. During the interviews, it became evident that most property owners did not actively work with construction logistics. Instead, the questions were often answered with how one can or should work. The suggestions on ways to develop their work with construction logistics were many and diverse.

Responsibility

As mentioned in section 4.1 The Current Role of Property Owners in Construction Logistics, most interviewees stated that the property owners today have little or no responsibility for construction logistics in a project. This is something that may change in the future. Interviewee P4 believes that high demands regarding sustainability will force them to develop their work with construction logistics.

It's not enough to change the material, you have to change everything, including logistics. Everything to reduce waste and improve efficiency.

- P4

Planning

Some interviewees believe that one way to meet future sustainability targets is to include construction logistics at an earlier stage in the construction process. The interviewees agreed upon what stage of the construction process construction logistics should be introduced. They said that construction logistics should be introduced as early as possible, but most found it difficult to specify exactly when in the process. Proposals mentioned when in the process to introduce construction logistics were the detailed development plan, the land allocation, or activities such as planning, tendering or design.

To get the full effect of construction logistics, construction logistics should be involved before you put the shovel in the ground. The earlier the better.

- C1

Correspondingly, interviewee U1 believes that it is important for the property owner to reflect upon what they aim to build, which volumes and the challenges it entails from a construction logistics perspective. This could result in fewer surprises during the construction phase and fewer claims between the property owner and contractor. Construction logistics should then be included throughout the whole process according to interviewee A1, although the approach may vary during the course of the project. Allocating money for construction logistics at an early stage increases the possibility that the method(s) will benefit the project. Two of the companies are currently endeavouring to not work with a de-centralised configuration, but have the goal that in the future all transports will be coordinated and planned within the project for both main contractors and subcontractors.

Logistics Strategy

To enable the improvement of construction logistics work, some interviewees believe that property owners need to start to show more interest in construction logistics and increase their understanding. One suggestion for how this can be done is for the property owner to produce a construction logistics strategy. The suggestion applies first and foremost to large property owners with many projects. The strategy should show how the company intends to work with construction logistics and a general framework for the contractors. It should be comprehensive so that it can be adapted to each individual project. If the strategy is included already in the pre-construction phase it can be a requirement for the contractor.

To be a contractor for us, you have to agree to these logistics requirements that we have or this logistics set-up that we have.

- A1

Logistics Analysis

Another suggestion mentioned by some interviewees is that the property owner could perform a logistics analysis during the pre-construction phase to analyse how the logistics flow can be managed and identify good solutions early on. The logistics analysis can then result in a logistics plan, indicating how to work and which logistics solution is suitable for each part of the project. Interviewee U2, believes that this type of analysis could be something that the municipality should approve before construction starts. Since construction logistics will become more important as cities become more exploited and more people are affected. In order to put pressure on the contractor to plan the construction logistics, some argue that the contractor should present a proposal for a logistics solution during tendering.

4.3.1 Defining Logistics Requirements

In section 4.1 The Current Role of Property Owners in Construction Logistics it was described how property owners make requirements on construction logistics today. The interviews implied that it was unusual to put specific requirements on

construction logistics. Instead, some interviewees gave examples of possible solutions for how property owners could do in the future which is presented below.

When asking about whether property owners should put requirements on construction logistics or not, six out of eight property owners and urban developers answered that property owners should do so. Where interviewee P2 argued that everything in construction is logistics and therefore, it should be included in the price. Interviewee P5 reasoned that making a text in a document is not the right way to go, instead, construction logistics should be planned through meetings through collaboration between the property owner and contractor. Just as the reasons why not to put requirements differed, opinions also differed on how the requirements should be formulated.

Among the interviewees that claimed that requirements should be placed, all argued that the property owners should be the ones that should place these requirements. In addition, it was also suggested that the city should take a larger responsibility regarding construction logistics. Both urban developers thought it was a good idea to impose requirements on land allocations. Interviewee U2 argues that the city should have a helicopter perspective when placing requirements to increase the socio-economical and ecological effects due to construction logistics. The interviewee suggested that the city could place requirements regarding improved transport efficiency which can be achieved with larger vehicles and co-loading. However, these high-capacity transports that were mentioned were still under development. Another suggestion was that the city could make requirements on which times construction transport should be allowed in dense areas to improve road safety and reduce urban congestion. Both Stockholm and London were mentioned as cities being at the forefront of making requirements on construction logistics.

As mentioned earlier, the opinions on how property owners should formulate the requirements in the future varied. Several interviewees felt that it was difficult to describe how the requirements should be formulated specifically. Most interviewees do not believe that property owners should control the exact methodology that contractors should apply for their work. Instead, property owners should work proactively with construction logistics and guide the contractors, as they are responsible for the success of the project as a whole. One property owner believes that functional requirements would be the better alternative to enable the contractor to solve the issue in the way they believe is the best. This is consistent with the views of several other interviewees who believe that procurement should drive innovation, which happens if property owners are open to new solutions and provide the necessary conditions to the contractor. In contrast to this, one interviewee said that property owners should make strict and clear requirements. Regardless of whether the interviewee argued that the requirements should be formulated strictly or not, none of them could define how these requirements could be formulated.

Even if none of the interviewees could give specific examples of how the requirements could be formulated, several suggestions were provided for what could be included in the requirements. One interviewee suggested that the property owner could require that the contractor employ a logistics manager at the site when building in dense

cities. Today most property owners demand someone to be responsible for the sustainability of a project. Therefore, one suggestion is to do the same with a logistics manager. The logistics manager should be hierarchically close to the project manager in order to have the mandate to decide on the logistics of the project. Another suggestion is that the property owner could procure a TPL that the contractor can use and include in the prerequisites when procuring the project. It can also be a requirement from the property owner that the contractor needs to work with a TPL. A TPL enables all hours of the day to be used as well as the construction work and the logistics work to be separated. Interviewee P5 means that:

Construction work should be separated from the service part so that construction workers can focus on value-adding work while a TPL takes care of machines and materials to create.

- P5

As stated above, some interviewees did not believe that requiring a specific solution was the way to go. Before making demands it is argued that the property owner should learn more about construction logistics and thereafter develop a construction logistics strategy which was mentioned in section 4.3 Future Opportunities for Property Owners. The strategy is not intended to require specific solutions, but rather to find a construction logistics solution based on a framework. More precisely how the strategy should be designed could the interviewees not answer. Several interviewees argue that construction projects can benefit if the property owners take a more active stance as it can help give the contractors the needed prerequisites to perform the project effectively.

The contractors asked in this interview study are in favour of clients placing requirements regarding construction logistics. Where one interviewee believes that it would be more even conditions for the contractors during tendering and procurement if construction logistics became visible in the budget. Another interviewee implies that if the property owner makes demands, the contractors need to deliver.

5

Discussion

This chapter presents an analysis comparing the gathered literature in chapter 2 Theoretical Framework with the results from the interviews in chapter 4 Result. The discussion aims to summarise these chapters and answer the research questions. The first section discusses the current situation and challenges from the perspective of property owners. This is followed by a section of the drivers to implement construction logistics for property owners. The third section consists of recommendations for how property owners could work in the future with construction logistics.

5.1 Fragmented Use of Construction Logistics

As mentioned in section 4.1 The Current Role of Property Owners in Construction Logistics, it became apparent that the view on construction logistics varied. The variation in responses confirms the theory that one of the main concerns for the construction industry is that it is fragmented (Boyd & Chinyio, 2006). The variation in responses also indicates that the industry is fragmented when it comes to construction logistics. Interviewed property owners work with construction logistics in several different ways both compared to each other and in different projects within their companies. It is shown that there is a fragmented use of construction logistics within the sector which can be a reason why the industry has difficulties in development. Something that is negative as many already see the construction sector as slow in development. Boyd and Chinyio (2006) argued that since all stakeholders have their own objectives they are in fact more loyal to their own organisation rather than the temporary project organisation, which increases fragmentation. Some of the main reasons for the fragmented use of construction logistics among property owners are discussed in this section.

Responsibility

The definition of a client implies that the overall responsibility of a project lies on the client (Kamara et al., 2002). However, the responsibility for construction logistics in a project is not apparent. The empirical study shows that most of the interviewees consider it to be the responsibility of the contractor. Several interviewees, on the other hand, believe that property owners should take a larger responsibility for construction logistics in projects. This corresponds to the statement by Challander and Whitaker (2019), who have identified the client as the stakeholder who has

the ability to influence the degree of integration in the supply chain. Additionally, Vrijhoef and Koskela (2000) mean that this is due to the fact that the client is involved in a wider context than just the specific construction project. The great potential of construction logistics to improve project efficiency should be reason enough for property owners to take greater responsibility for developing the logistics in their projects.

Set Requirements

Morledge and Smith (2013) claim that fewer investments are done in the construction sector compared to other industries, instead, innovation is driven by changes in laws. This is somewhat consistent with the results of the interviews. According to Byggföreningen (2020a), the client has a great opportunity to put high demands on the innovation of climate-smart solutions to force the construction sector to develop. To improve productivity in projects, property owners need to take greater responsibility and set more requirements. However, this only happens on the initiative of laws and regulations changes that are made linked to sustainability. The lack of requirements presents an opportunity for collaboration between various actors to develop standardised formulations of requirements.

Lack of Early Logistics Planning

Planning for construction logistics should be essential to maximise project productivity (Agapiou et al., 1998). Several interviewees believe that planning construction logistics should start during the pre-construction phase to improve project predictability and reduce the number of surprises. Despite this, only a few of the property owners and urban developers planned for construction logistics at an early stage. The literature has pointed to the importance of early planning for many years (Agapiou et al., 1998; Sullivan et al., 2010), yet property owners do not apply it in their projects.

Too High Costs

The authors see cost as a major reason why construction logistics are not implemented earlier in projects. One of the interviews showed that a joint logistics solution was not procured because the costs were considered too high and the contractor believed that they could solve the logistics on their own. As a result, the logistics costs are hidden in other costs and the contractors for the individual projects solve the logistics without coordination with neighbouring projects. The property owners then have no insight into what the costs actually are and are unable to influence the contractors from a logistics perspective. To see the benefits of construction logistics and how it can contribute to reducing project costs, construction logistics costs should be treated separately from other costs. Furthermore, if the property owner shows interest in construction logistics and takes greater responsibility to plan it, other costs could be reduced.

No Common Working Method

Property owners and the sector face challenges in terms of development as there are no standardised working methods for how property owners should work with construction logistics. As mentioned, none of the interviewees worked in the same way. The approach had to be customised for each individual project. Only one prop-

erty owner has developed a standardised working method for construction logistics. The construction sector is characterised as project-based and every project is unique (Challander & Whitaker, 2019). The fact that it is project-based is mentioned as an excuse for a fragmented industry and the difficulty of learning from previous projects. However, the authors believe that it is too often used as an excuse. There is a lot that is repetitive and a more standardised approach would benefit property owners and the industry.

Variation of Knowledge about Logistics

The knowledge of construction logistics is varied in the construction sector. In sectors such as manufacturing, the benefits and knowledge are much more widely developed. The variation of knowledge creates a barrier for the construction sector to work with and develop the supply chain. However, there are some enthusiasts trying to spread knowledge and lessons learnt to develop construction logistics. Much of this work and the existing literature focuses on how the contractor can improve their work, rather than on the client who is more likely to address logistics at an early stage. As mentioned in the results, those property owners who do not work much with construction logistics have also not learnt anything from previous projects. The reason for this could be that some property owners consider construction logistics to be the responsibility of the contractor. This shows a lack of commitment to the subject and having enough knowledge to be able to learn from previous projects.

Rare to Use Construction Logistics Setups

Almost none of the property owners work with logistics as suggested in the literature and few mention the possible construction logistics setups. Dubois (2019) suggests that projects in dense cities should be coordinated by the on-site configuration or the supply network configuration. Only two property owners require this type of setup, instead, they leave the decision to the contractor. As one of the interviewees mentioned, the logistics solution has to be adapted depending on the project and during the project. The authors asked open questions during the interviews that did not provide the interviewees with any suggestions or indicators of what the literature indicates about construction logistics or construction logistics solutions. This can be one reason why most interviewees did not mention solutions such as CCC, checkpoints or TPLs. The answers mostly focused on the transports. This indicates that the interviewees have a narrow perspective of construction logistics and most do not see the entire supply chain or all the different areas construction logistics can have an impact on. During the interviews, it became evident that property owners with greater interest in the construction phase have come much further than the other property owners regarding construction logistics. The biggest obstacle for not working with construction logistics seems to be that the clients do not know exactly what to demand. Further, the reason seems to be that they are not familiar with the construction phase and instead believe that the contractor will solve it and that they do not want to control the details.

Monitoring of Logistics Requirements

The interviews revealed that property owners do not actively monitor if logistics requirements are followed. The conclusion was that as long as no complaints arise, property owners do not seem to inquire about the efficiency of the work being carried out. These arguments indicate that the property owners are not actively working to improve the execution of the project and especially the logistics performance.

5.2 Driving Forces for Construction Logistics

From the interviews, a number of driving forces to work with construction logistics emerged. A compilation of found driving forces and their connection to the aspects of sustainability is presented in figure 5.1. The result of the interviews showed that there was a wide spread of suggestions on how costs could be reduced, the reason why the location was important, and ideas of solutions to minimise the risk of delay. A possible reason for the spread of the responses could be that the interviewees only received open questions. Therefore, the interviewees responded according to their own knowledge.

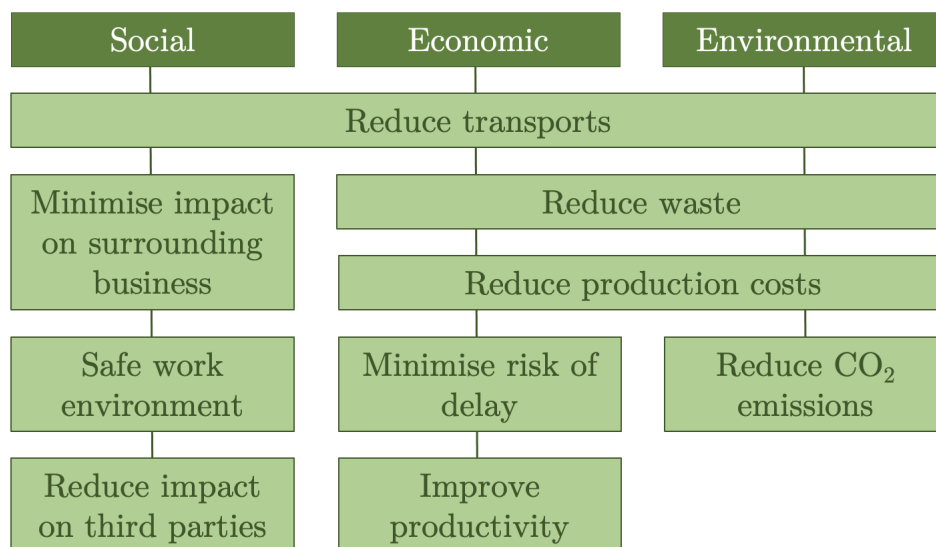


Figure 5.1: Property owners driving forces to work with construction logistics in connection to how these impact sustainability.

As mentioned in the result, several interviewees could not give examples of how construction logistics could contribute to social sustainability. However, when it was described to them that fewer vehicles on site can result in a safer construction site, less noise, and improved air quality (Guerlain et al., 2019) all interviewees agreed with the literature. This indicates that if the interviewees had received different alternatives of how the social, economic, and environmental sustainability could have been affected by construction logistics, the compilation of figure 4.1 would look different and probably have more piles with 100% answer rate. On the other

hand, due to the diverse range of answers, it can be inferred that property owners can gain knowledge in this area and have not yet identified an optimal method for handling construction logistics. Nevertheless, the extensive array of answers indicates considerable possibilities in construction logistics for property owners. This is further supported by the literature, which will be discussed in the following section.

As mentioned earlier, Sweden has a goal to become climate neutral by 2045 and partly already by 2030 (Sveriges miljömål, 2023; Göteborgs Stad, n.d.). Meanwhile, the construction industry represents a fifth of the CO_2 -emissions (Boverket, 2023a). Correspondingly, one of the interviewees raised that to reach the targets for 2030, many measures need to be taken in the coming years, including the area of construction logistics. With the combination of high sustainability targets and the construction industry being a large contributor to emissions and waste production, it is evident that it is important to take a leap in becoming more innovative and have the courage to invest in new solutions.

When compiling the result in figure 4.1 several aspects can be allocated to several categories as many of the effects have mutual effects. For example, reducing the amount of waste can result in both reduced CO_2 -emissions and improved cost control. In the same way, reducing the number of transports can be connected to reduced CO_2 -emissions, improved cost control, reduced impact on third parties, and a safe work environment. Since all respondents mentioned minimise CO_2 -emission, it was decided that this should be a separate category, even if it often was mentioned in combination with other things such as reduced number of transports or waste. The same applies to improved cost control which also was mentioned in combination with either a reduced number of transports or waste.

Reduce Production Costs

SCM was identified as a solution to minimise problems such as cost overruns and delays in production (Ekeskär & Rudberg, 2016; Briscoe et al., 2004). The interviews showed that reducing production costs is a large driving force for property owners to work with construction logistics as they are the ones who pay in the end. The four roles of supply chain described by Vrijhof and Koskela (2000) describe different ways of reducing costs and duration of activities through different SCM improvements. They describe that property owners have a unique fifth role as they can govern all four roles of SCM. This implies that the property owner has large possibilities to make a change. However, the article by Vrijhof and Koskela (2000) does not describe the fifth role deeper. It can be argued that there is a gap in the literature regarding specific recommendations for property owners and other clients. The interviews covered answers regarding the first, the second, and the fourth role. On the other hand, none of the interviewees answered that focusing on off-site production and industrialisation could be a way of reducing costs and duration of activities. This can indicate a lack of knowledge among property owners. The article by Vrijhof and Koskela (2000) is not new and aiming to increase off-site production and industrialisation of the sector is a fairly normal measure when trying to improve lead times and duration of activities, especially as the construction industry often is looking to the automotive industry when examining how to improve.

Reduce Waste

Since property owners pay both for all materials purchased and for all materials removed from the construction site as waste, the drive to reduce waste can have both economic and environmental incentives. Today, the construction sector generates 40% of the total waste production in Sweden (Boverket, 2023a). In addition, 30-35% of the production costs can be related to waste management (Ekeskär & Rudberg, 2016). The literature shows that from an ecological point of view, the most favourable measure would be to reuse material that otherwise would be treated as waste (Sullivan et al., 2010). However, there are several challenges in reusing materials as costs for transport, storage, and finding a new project often overrun the costs of transporting it away as waste. Instead, improved material planning in the pre-construction phase, applying the lean approach and using JIT deliveries in the construction phase can reduce material costs and thereby reduce waste.

Reduce Transport

In addition to the goal of having net zero emissions by 2045, additional goals for transports have been placed for 2030 as transports are one of the main contributors to CO_2 -emissions (Sveriges miljömål, 2023). In addition to the environmental objectives, there are also large cost savings that can be done due to reduced amount of transport as transportation in construction projects can be estimated to be 10-20% of the production costs (Sullivan et al., 2010; Dubois & Gadde, 2002). Reducing the number of transports can have environmental, economic, and social effects. The interviewees most often identified the economic and environmental benefits. In contrast, many of them could not find the social aspect despite the fact that transportation has the potential to improve several social aspects both on-site and off-site. Such as improved road safety, less noise in cities, less traffic on site and thereby decreased risk of accidents. The fact that the interviewees had trouble finding social benefits of construction logistics even if it was asked for specifically is another indication that there could be a lack of knowledge among property owners. Abrahamson et al. (2019) imply that working with construction logistics has the potential to reduce transportation by 60-80%, it is interesting that this has been confirmed by one of the interviewees that mentioned that their company could reduce their transport by 80% by using a CCC and planning their deliveries to all construction within the same geographical area. This acknowledges that the figures presented by Abrahamson et al. are achievable.

Minimise Impact on Surrounding Business

From the interviews, it became evident that the location of construction projects affects the importance of construction logistics for property owners. Various reasons were mentioned, from a property owner's perspective, it can be argued that minimising the impact on surrounding businesses and tenants can be a driving force for working with construction logistics. This aspect has several dimensions, firstly, property owners have an interest to enable businesses to run as business owners otherwise can not pay their rents. Secondly, a low focus on construction logistics can result in an increase in complaints from tenants which can result in bad relationships between property owners and tenants. Thirdly, analysing construction logistics early can contribute to identifying whether it is possible to carry out the proposed

project or not. Sullivan et al. (2010) mentioned that often clients have requirements that the construction should have limited disturbances of the surrounding is often correlated to tight time schedules as the area of construction needs to return to normal as quickly as possible. This specific correlation between minimising impact on surrounding and quick completion of projects was not highlighted by the interviewees. However, minimising impact on the surrounding business increases the demand for planning and effective construction logistics. This in combination with a quick completion of the project increases the demand for construction logistics even further.

Minimise the Risk of Delay

The property owner is the one financing construction projects, as a property owner, money is earned first when the construction project is finished and tenants move in and start to pay rent. Therefore, property owners have a large interest in completing projects on time. The literature shows that the construction industry has issues regarding productivity due to uncertainty in the supply chain, varying site conditions, and varying capacity conditions (Vrijhoef & Koskela, 2000). As mentioned earlier, the interviews revealed that discussing construction logistics in the pre-construction phase could reduce the risk of surprises showing up in the construction phase that can result in risk of delay of the project.

Improve Productivity

It is surprising that the interviews show that only one of the property owners actively works with a focus on improved productivity. When the other interviewees discussed construction logistics, there was very little focus on on-site activities and productivity improvements. The literature shows that construction workers spend 30% of their working time waiting and an additional 20% of their time moving materials around (Ekeskär & Rudberg, 2016). In addition to this, less than 40% of deliveries to construction projects arrive according to the order and without damage (Ekeskär & Rudberg, 2016). These should be figures that make property owners actively work hard to improve the efficiency of their projects. Nevertheless, none of the interviewed property owners highlighted a lack of productivity during the interviews as a problem or driver for working with construction logistics. This is problematic because there is really no incentive for contractors to try to improve if property owners choose to pay for all workers to spend a third of their working day just waiting, and another 20% of the day moving materials. From a larger perspective, the ineffective construction industry affects everyone, either due to projects being financed with taxes or by paying higher rents for our homes or offices, which affects both private individuals and business customers and thus society as a whole. In terms of sustainability, inefficiencies result in more transport and waste.

6

Recommendations for Property Owners

The following recommendations are aimed for property owners interested in improving their work with construction logistics in projects. As mentioned in the literature, property owners have a great opportunity to influence the realisation of a project. Construction logistics, in turn, has the potential to help ensure that projects are carried out efficiently, at a reasonable price and without adversely affecting sustainability.

Based on the literature and interview study, a number of recommendations related to construction logistics have been identified. An overview of the recommendations is presented in figure 6.1. However, the combination of applying all these activities in the suggested order is only a proposal by the authors of the study and has not been tested in practice.

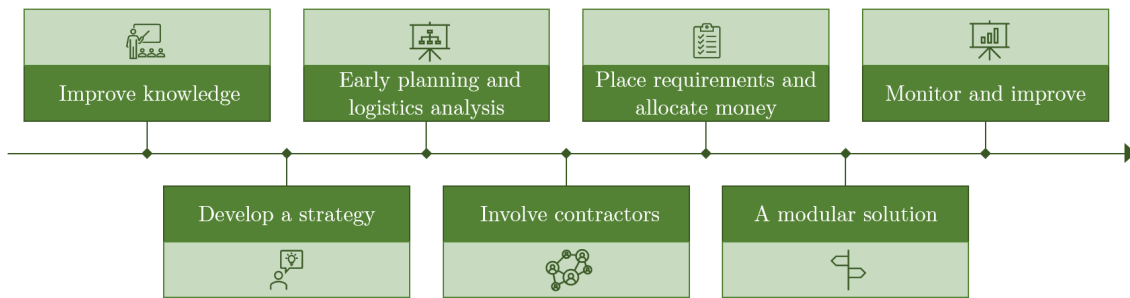


Figure 6.1: A timeline describing the order in which property owners can perform different construction logistics activities.

Improve Knowledge

As mentioned several times, the property owner has the possibility to affect all parts of the supply chain due to their holistic role. In addition, the empirical study shows that knowledge in the industry can be improved regarding construction logistics. Therefore, it should be suggested that property owners should deepen their knowledge so that they can take knowledge-based decisions, become more active during execution, and put requirements on improved productivity along the supply chain. Through workshops and seminars by experts in the field, property owners can easily

absorb information and thus increase their knowledge of construction logistics and share ideas.

Develop a Strategy

Once the property owner has gathered knowledge, the next step could be to develop a construction logistics strategy. In accordance with the results of the interviews, the authors suggest that strategy should align with the company's sustainability goals and create a framework for how construction logistics should be addressed in their construction projects. The strategy should be used as a guideline to find the most suitable construction logistics setup for the specific project.

Early Planning and Logistics Analysis

When a decision is made to build something, logistics should be taken into account. Some interviewees recommended that a logistics analysis can be performed to identify the prerequisites for the project and identify risks and opportunities. It is found that construction logistics should be considered in the pre-construction phase to maximise the potential of the logistics solutions. If construction logistics is considered too late, it may be too late to apply certain CLPs.

Early Involvement of Contractors

The literature suggests that clients should include contractors before tendering, to clarify the tender documents (Kamara et al., 2000). This can be appropriate as property owners' experience with construction logistics varies. Since contractors have closer relation to the execution of projects than property owners they can find obscurities in the tender documents which can facilitate later phases of the project.

Place Requirements and Allocate Money

The next step is to put requirements on the contractor. None of the interviewees could clearly define how the requirements should be formulated, however, some mentioned that functional requirements can be used. Functional requirements define the aim with the solution but no specific solution, this corresponds to the literature regarding requirements which also states that requirements should be solution neutral (Kamara et al., 2002). As mentioned previously, construction logistics must be discussed early in the project. If there is no allocated money in the budget, it will be hard for the contractor to work seriously with construction logistics. Hence, the costs for it will be covered by hidden costs where no one will be aware of the final price. One interviewee claims that working with construction logistics will cost money on one end and save money on another end. Including logistics early also enables the contractor to put requirements on the sub-contractors.

A Modular Solution

It is not possible to say that a specific CLS is suitable for all construction projects. Therefore, it is important to find which solution that suits the current project. One recommendation mentioned in the interviews was that the logistics solution should be of the modular type. Meaning that different construction logistics solutions are applied to different phases of the project. Examples of different modules that can be combined are presented in figure 6.2. Further, Janné (2020) suggests that it can be relevant to coordinate logistics solutions between neighbouring projects within the

same geographical area. Both the logistics analysis and the logistics strategy can be used for decision support when selecting appropriate CLSs in different construction project phases.



Figure 6.2: Proposals of different CLSs that can be used as modular solutions in various combinations and in different phases of projects.

Monitoring and Improving

The aim of working with construction logistics is to find cost-effective, strategically suitable solutions, and optimize material flow (Sullivan et al., 2010). In order to find if the requirements and objectives of the construction logistics strategy are fulfilled the logistics solution needs to be monitored. The empirical study showed that property owners often do not measure logistics performance as they perceive that their current objectives are achieved if their tenants do not complain. If property owners adopt a strategic approach to construction logistics, measuring progress is recommended. Since measuring enables possibilities to enhance the solution and identify inefficiencies (Ying et al., 2018; Janné, 2020).

7

Conclusion

The aim of this study was to investigate how property owners currently work with construction logistics and possible ways to work with it in the future. As of today, the construction industry is one of the main contributors to CO_2 -emissions. Construction logistics possess the potential to mitigate the environmental footprint and enhance the operational efficiency of the construction industry. The investigation is grounded in the perspective of property owners, who besides new rules and regulations, serve as drivers for innovation within the industry. Despite this, the property owner's perspective in relation to construction logistics is rather rare in literature. Thus, the objective of this study is to bridge the research gap and emphasise the opportunities available to property owners within the area of construction logistics. The results of the research questions have been gathered through interviews and a literature overview and will be briefly presented in this chapter.

RQ1: *How do property owners work with construction logistics today?*

This study shows that property owners working methods with construction logistics vary. In general, property owners do not work specifically with construction logistics. There are also no requirements for specific requirements in combination with logistics for the contractor, beyond the existing rules and regulations that apply to all projects or to particular circumstances. The costs of construction logistics are often unknown due to the inclusion in the price. The finding is that property owners do not work actively in the execution of construction, many believe that it is the contractor's responsibility to carry out the logistics in an efficient way, which could be a reason why many have a rather narrow view of what construction logistics could entail.

RQ2: *Which are the main drivers to work with construction logistics for property owners from a sustainability perspective?*

The general attitude towards construction logistics is favourable, and most property owners can see potential in construction logistics. Property owners identified reduced production costs, minimised impact on surrounding businesses, and reduced risk of delay as general driving forces to work with construction logistics. From a sustainability perspective, the following drivers were found as the most important:

- Minimise CO_2 -emissions
- Reduce transports
- Reduce waste
- Improve cost control
- Reduce impact on third parties
- Safe work environment

RQ3: *How should property owners work with construction logistics in the future?*

The result of this study shows that there is no specific construction logistic setup that suits all construction projects. In the same way, property owners should not require specific solutions for each of their projects. Further, there are no specific examples of how the formulation of requirements should be presented. However, this study implies that property owners could gain by taking a more active stance towards construction logistics, participating more actively in the execution and requiring improvement. The found recommendations are:

- Improve knowledge
- Develop a strategy
- Early planning and logistics analysis
- Involve contractors
- Place requirements and allocate money
- A modular solution
- Monitor and improve

7.1 Future Research

This study has found recommendations for how property owners can improve their work with construction logistics. Future research could investigate how construction logistics requirements should be formulated by property owners. This would enable property owners to work strategically with construction logistics and set reasonable requirements for actors involved in their projects.

Furthermore, future studies can explore how construction logistics strategies can be designed. This could be done by proposing a case study where one or more logistics strategies are evaluated or compared. If a study shows applicable examples of what

a strategy can look like, it will be easier for the property owner to apply this in their work process.

A final suggestion is that this study can be followed up with a survey-based study where more respondents can be reached and respondents can rank the drivers for working with construction logistics. Since more respondents can help to make clearer and more reliable conclusions.

References

- Abrahamsson, M., Fredriksson, A., Hüge Brodin, M., Engevall, S., & Lindahl, P. (2019). *Fossilfri bygglogistik - En förstudie* (Tech. Rep.). Retrieved from <https://logistikia.se/wp/custom/uploads/2021/01/Slutrapport-Forstudie-Fossilfri-Bygglogistik-Triple-F-2019.pdf>
- Agapiou, A., Clausen, L. E., Flanagan, R., Norman, G., & Notman, D. (1998). The role of logistics in the materials flow control process. *Construction Management and Economics*, 16(2), 131–137. doi: 10.1080/014461998372420
- Akintoye, A. (1995). Just-in-Time application and implementation for building material management. *Construction Management and Economics*, 13, 105–113.
- Arbetsmiljöverket. (2022). *Byggherren*. Retrieved from <https://www.av.se/produktion-industri-och-logistik/bygg/ansvar-vid-byggnads--och-anlaggningsarbete/byggherren/#>
- Bamana, F., Lehoux, N., & Cloutier, C. (2019, 5). Simulation of a Construction Project: Assessing Impact of Just-in-Time and Lean Principles. *Journal of Construction Engineering and Management*, 145(5). doi: 10.1061/(asce)co.1943-7862.0001654
- Bell, E., Bryman, A., & Harley, B. (2022). *Business research methods* (6th ed.). Oxford: Oxford University Press.
- Boverket. (2020a). *Byggherrens ansvar*. Retrieved from <https://www.boverket.se/sv/PBL-kunskapsbanken/lov--byggande/byggprocessen/byggherrens-ansvar/>
- Boverket. (2020b). *Bygg- och anläggningslogistik*. Retrieved from <https://www.boverket.se/sv/PBL-kunskapsbanken/teman/godstransporter-i-fysisk-planering/lorande-exempel/bygg---och-anlaggningslogistik/>
- Boverket. (2021a). *Entreprenadformer och kvalitet*. Retrieved from <https://www.boverket.se/sv/samhallsplanering/arkitektur-och-gestaltad-livsmiljo/arbetssatt/upphandling/entreprenadformer/>
- Boverket. (2021b). *Olika skeden i byggandet*. Retrieved from https://www.boverket.se/sv/PBL-kunskapsbanken/teman/ekosystemtjanster/metod_byggande/skeden/
- Boverket. (2023a). *Miljöindikatorer - aktuell status*. Retrieved from <https://www.boverket.se/sv/byggande/hallbart-byggande-och-forvaltning/miljoindikatorer---aktuell-status/>

- Boverket. (2023b). *Types of contract and procurement*. Retrieved from <https://www.boverket.se/en/start/building-in-sweden/developer/rfq-documentation/types-of-contract/>
- Boyd, D., & Chinyio, E. (2006). *Understanding the Construction Client* (1st ed.). John Wiley & Sons. Retrieved from <https://ebookcentral.proquest.com/lib/chalmers/detail.action?docID=351638>
- Briscoe, G. H., Dainty, A. R., Millett, S. J., & Neale, R. H. (2004, 2). Client-led strategies for construction supply chain improvement. *Construction Management and Economics*, 22(2), 193–201. doi: 10.1080/0144619042000201394
- Burnard, P., Gill, P., Stewart, K., Treasure, E., & Chadwick, B. (2008, 4). Analysing and presenting qualitative data. *British Dental Journal*, 204(8), 429–432. doi: 10.1038/sj.bdj.2008.292
- Byggföretagen. (2020a). *Rekommendationer för klimatkrav i upphandling - Bilaga till vägledning för hållbar upphandling* (Tech. Rep.). Retrieved from https://www.trafikverket.se/contentassets/37bef9edb8724253b0190cb65cdc3254/vagledning_v_1_0_160129.pdf
- Byggföretagen. (2020b). *Vägledning – Hållbar upphandling i bygg- och anläggningssektorn*.
- Byggföretagen. (2020c). *Viktigt på riktigt -Handledning för privata beställare*.
- Byggföretagen. (2022). *Sänkt marginals katt-Jobbeffekter via byggföretag och deras underleverantörer*.
- Byggherrarna. (2018). *Tillämpningsföreskrifter totalentreprenadkontrakt partnering* (Tech. Rep.). Stockholm.
- Challander, J., & Whitaker, R. (2019). *The Client Role in Successful Construction Projects*. Routledge.
- Chinyio, E., & Olomolaiye, P. (2010). *Construction Stakeholder Management*. John Wiley & Sons.
- Christopher, M. (2016). *LOGISTICS & SUPPLY CHAIN MANAGEMENT* (Fifth ed.). Pearson Uk. Retrieved from www.pearson-books.com
- Circularity Gap Reporting Initiative. (2022). *The Circularity Gap Report Sweden* (Tech. Rep.). Retrieved from <https://www.circle-economy.com/resources/circularity-gap-report-sweden>
- CIVIC. (2018). *The CIVIC Handbook for Smart Construction Logistics*. Retrieved from <https://www.civic-project.eu/en/news/civic-final-report-now-available>
- Construction Contracts Committee. (2004). AB 04. Allmänna bestämmelser för byggnads-, anläggnings-, och installationsentreprenader. *Svensk Byggtjänst*.
- Dubois, A., & Gadde, L. E. (2002). The construction industry as a loosely coupled system: Implications for productivity and innovation. *Construction Management and Economics*, 20(7), 621–631. doi: 10.1080/01446190210163543
- Dubois, A., Hulthén, K., & Sundquist, V. (2019). Organising logistics and transport activities in construction. *International Journal of Logistics Management*, 30(2), 620–640. doi: 10.1108/IJLM-12-2017-0325
- Egan, J. (2002). *Accelerating Change* (Tech. Rep.).
- Ekeskär, A., & Rudberg, M. (2016). Third-party Logistics in Construction: the

- Case of a Large Hospital Project. *Construction Management and Economics*, 34(3), 174–191. doi: 10.1080/01446193.2016.1186809
- Fadiya, O., Georgakis, P., Chinyio, E., & Nwagboso, C. (2015). Decision-making framework for selecting ICT-based construction logistics systems. *Journal of Engineering, Design and Technology*, 13(2), 260–281. doi: 10.1108/JEDT-07-2011-0047
- Fewings, P., & Henjewe, C. (2019). *Construction Project Management: An Integrated Approach*. Routledge.
- Flick, U. (2018). *Doing Qualitative Data Collection*. SAGE Publications Ltd. Retrieved from <https://methods.sagepub.com/book/the-sage-handbook-of-qualitative-data-collection/i318.xml> doi: <https://doi.org/10.4135/9781526416070>
- Göteborgs Stad. (n.d.). *Klimatneutrala Göteborg 2030*. Retrieved from <https://goteborg.se/wps/portal/enhetssida/goteborgs-stads-innovationsarbete/innovationsprojekt/klimatneutrala-goteborg-2030>
- Guba, E. G., & Lincoln, Y. S. (1982). Epistemological and Methodological Bases of Naturalistic Inquiry. *ECTJ*, 30(4), 233–252.
- Guerlain, C., Renault, S., & Ferrero, F. (2019). Understanding Construction Logistics in Urban Areas and Lowering Its Environmental Impact: A Focus on Construction Consolidation Centres. *Sustainability*, 11(21). doi: 10.3390/su11216118
- Howell, G. A. (1999). *What is lean construction - 1999* (Vol. 7). Citeseer: Proceedings IGCL.
- Ingemansson Havenvid, M., Hulthén, K., Linné, , & Sundquist, V. (2016, 11). Renewal in construction projects: tracing effects of client requirements. *Construction Management and Economics*, 34(11), 790–807. doi: 10.1080/01446193.2016.1208364
- Janné, M. (2020). *Construction Logistics in a City Development Setting* (Tech. Rep.). Linköping: Linköping University.
- Janné, M., & Rudberg, M. (2022). Effects of employing third-party logistics arrangements in construction projects. *Production Planning and Control*, 33(1), 71–83. doi: 10.1080/09537287.2020.1821925
- Kamara, J. M., Anumba, C. J., & Evbuomwan, N. F. O. (2000). Establishing and processing client requirements-a key aspect of concurrent engineering in construction. *Engineering, Construction and Architectural Management*, 7(1), 15–28.
- Kamara, J. M., Anumba, C. J., & Evbuomwan, N. F. O. (2002). *Capturing client requirements in construction projects*. Thomas Telford Limited.
- Kometa, S. T., Olomolaiye, P. O., & Harris, F. C. (1995). An evaluation of clients' needs and responsibilities in the construction process. *Engineering, Construction and Architectural Management*, 57–76.
- Kordi, N. E., Belayutham, S., & Che Ibrahim, C. K. I. (2021). Mapping of social sustainability attributes to stakeholders' involvement in construction project life cycle. *Construction Management and Economics*, 39(6), 513–532. doi: 10.1080/01446193.2021.1923767

- Lambert, D., & Cooper, M. (2000). Issues in Supply Chain Management. *Industrial Marketing Management*, 29, 65–83. Retrieved from <http://www.CLM1.org>.
- Ling, F. Y. Y., & Kerh, S. H. (2004). Comparing the performance of design-build and design-bid-build building projects in Singapore. *Architectural Science Review*, 47(2), 163–175. doi: 10.1080/00038628.2004.9697040
- Morledge, R., & Smith, A. (2013). *Building Procurement*. John Wiley & Sons, Incorporated. Retrieved from <https://ebookcentral.proquest.com/lib/chalmers/reader.action?docID=1137787>
- Muerza, V., & Guerlain, C. (2021, 7). Sustainable construction logistics in urban areas: A framework for assessing the suitability of the implementation of construction consolidation centres. *Sustainability (Switzerland)*, 13(13). doi: 10.3390/su13137349
- Nordstrand, U. (2008). *Byggprocessen* (4th ed.). Liber AB.
- Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017, 9). Thematic Analysis: Striving to Meet the Trustworthiness Criteria. *International Journal of Qualitative Methods*, 16(1). doi: 10.1177/1609406917733847
- Projektledning. (2021). *Entreprenadform: På vilket sätt vill du bygga ditt hus?* Retrieved from <https://projektledning.se/entreprenadform/>
- Regeringsbeslut Fi2022/00506. (2022). *Uppdrag att utveckla arbetet med omställningen till en cirkulär ekonomi i byggsektorn*. Regeringskansliet. Retrieved from <https://www.regeringen.se>
- Salem, O., Solomon, J., Genaidy, A., & Minkarah, I. (2006). Lean Construction: From Theory to Implementation. *Journal of management in engineering*, 22(4), 168–175. doi: 10.1061/ASCE0742-597X200622:4168
- Statistiska Centralbyrån. (2022). *Tätorter i Sverige*. Retrieved from <https://www.scb.se/hitta-statistik/sverige-i-siffror/miljo/tatorter-i-sverige/>
- Sullivan, G., Barthorpe, S., & Robbins, S. (2010). *Managing Construction Logistics*. John Wiley & Sons, Incorporated. Retrieved from <https://ebookcentral.proquest.com/lib/chalmers/reader.action?docID=537375>
- Sundquist, V., Gadde, L. E., & Hulthén, K. (2018, 1). Reorganizing construction logistics for improved performance. *Construction Management and Economics*, 36(1), 49–65. doi: 10.1080/01446193.2017.1356931
- Susong, M. (2006). *The Construction Project: Phases, People, Terms, Paperwork, Processes*. American Bar Association. Retrieved from https://books.google.se/books?hl=sv&lr=&id=VFZ8TTPyG-oC&oi=fnd&pg=PR15&dq=construction+phases&ots=_4bIqH09G8&sig=tNV_G5ZC0PnASmbE3svaNuXN4FI&redir_esc=y#v=onepage&q=construction%20phases&f=false
- Sveriges miljömål. (2023, 4). *Utsläpp av växthusgaser till år 2030*. Retrieved from <https://www.sverigesmiljomal.se/etappmalen/utslapp-av-vaxthusgaser-till-ar-2030/>
- Thompson, P. (1991). The client role in project management. *International Journal of Project Management*, 9(2), 90–92.
- Vrijhoef, R., & Koskela, L. (2000). The four roles of supply chain management in construction. *European Journal of Purchasing & Supply Management*, 6,

- 169–178.
- Wen, Q., Qiang, M., & An, N. (2017, 7). Collaborating with Construction Management Consultants in Project Execution: Responsibility Delegation and Capability Integration. *Journal of Construction Engineering and Management*, *143*(7). doi: 10.1061/(asce)co.1943-7862.0001312
- Winch, G. (2009). *Managing Construction Projects* (2nd ed.). John Wiley & Sons, Incorporated. Retrieved from <https://ebookcentral.proquest.com/lib/chalmers/detail.action?docID=698479>
- Winch, G., & Leiringer, R. (2016, 2). Owner project capabilities for infrastructure development: A review and development of the "strong owner" concept. *International Journal of Project Management*, *34*(2), 271–281. doi: 10.1016/j.ijproman.2015.02.002
- Winch, G. M. (2003). How innovative is construction? Comparing aggregated data on construction innovation and other sectors - A case of apples and pears. *Construction Management and Economics*, *21*(6), 651–654. doi: 10.1080/0144619032000113708
- World Commission on Environment and Development. (1987). *Our Common Future*. Oxford. Retrieved from <https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf>
- Ying, F., Tookey, J., & Seadon, J. (2018, 8). Measuring the invisible: A key performance indicator for managing construction logistics performance. *Benchmarking*, *25*(6), 1921–1934. doi: 10.1108/BIJ-11-2016-0176

A

Interview Questions

List of Interview Questions

General Questions

1. May we record the interview?
2. Is it okay to mention your professional role and company name in the thesis?
3. Can you introduce yourself and your current role?

Construction Logistics

1. Do you work with construction logistics and how do you do it?
 - (a) When in your process do you start thinking of construction logistics?
 - (b) If not, why?
 - i. Which hinders appears?
2. Do you as a property owner see any advantages with construction logistics?
3. Have you made any learnings from previous projects regarding construction logistics?
 - (a) Have previous projects led to new standardised approaches to construction logistics?
4. What potential could construction logistics have for property owners in the future?

Requirements

1. Does your work on construction logistics differ depending on the type of contract?
 - (a) What is the most common form of contract you use?
 - (b) If not, whose responsibility is it?

A. Interview Questions

2. How do you put requirements regarding construction logistics?
 - (a) Which actor should place requirements on construction logistics?
 - (b) Which requirements have you placed in previous projects?
 - (c) How should one put requirements on construction logistics?
 - i. Who should place these requirements?
 - (d) How do you follow up that the requirements are met?
3. Which benefits do you perceive by placing requirements on construction logistics?

Sustainability

1. In which way do you believe that construction logistics can affect your work regarding sustainability?
 - (a) How can construction logistics help you achieve your sustainability goals?
 - (b) What needs to be done to get there?
2. How do you follow up that the requirements regarding logistics in connection to sustainability are met?
3. Do you have any logistics solutions that have a large potential for your work regarding sustainability?

Is there anything regarding this topic that you would like to add?

Do you have any suggestions on who we should interview in this area?

Is it okay if we contact you again if we have follow-up questions at a later date?

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