Outsourcing Construction Logistics in a Rural Area

An Evaluation of a TPL-arrangement

Master's thesis in Design and Construction Project Management

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Abstract

Historically, the construction industry has suffered from low efficiency and poor performance. The management of the logistics activities has been found to be one main cause for this lagging performance. To facilitate construction logistics, TPL has emerged as a phenomenon that can enhance the industry's performance. However, most studies of TPL concern complex projects situated in urban areas. In addition, these projects commonly have a lack of space for storage or are located in areas which are sensitive for disturbances. Thereby, this master's thesis aimed to fill a gap in TPL research by examining a project situated in a rural area with plenty of space for storage, where the environment was not remarkably sensitive for disturbances. The purpose of the study was to examine the experienced effects of the TPL-arrangement. The thesis also investigated how the project's prerequisites and preparations made prior to application affected the outcome of the TPL-arrangement. To reach the purpose, a literature review was conducted together with 17 semi-structured interviews and a site visit.

The results showed that it is important to early involve the TPL-provider to reach the desired outcome, both in the planning and in the production. It is also important to anchor the solution among all involved actors, i.e., to make sure that everyone understand why it is applied and why it is applied at the specific time. If it is not sufficiently anchored, scepticism can arise which results in that actors deviate from the set restrictions, which in the long run harms the outcome of the TPL-arrangement. Lastly, to be able to monitor a project's logistics performance, it is necessary to break down the objectives into more tangible targets that can be measured in the daily production.

Keywords: Checkpoint, Construction Logistics, Delivery Restrictions, Inbound Materials Flow, Third-Party Logistics

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Beatrice Magnusson & Pernilla Hermansson, Gothenburg, June 2022

List of Acronyms

CCC	Construction Consolidation Centre
JIT	Just In Time
SCM	Supply Chain Management
TPL	Third Party Logistics

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1 Introduction

Historically, the construction industry has suffered from poor performance and low efficiency (Guerlain et al., 2019; Agarwal et al., 2016; Fulford and Standing, 2014). Less than 40% of the deliveries to a construction site are delivered free from damage, in the correct volume, to the right location at the right time (Thunberg and Persson, 2014). Approximately 30% of the delivered materials turn into waste (Osmani, 2011), whereof the costs of the waste can account for 30-40% of the total production cost (Josephson and Saukkoriipi, 2007). According to Dubois et al. (2019), one main cause for the poor performance is the construction supply chain.

Traditionally, the supply of materials to construction sites has been handled by contractors and subcontractors with minimum consideration of joint coordination (Dubois et al., 2019). The on-site logistics activities have been perceived as a part of the construction process that is taken care of by craftsmen (Lindén and Josephson, 2013). Thereby, materials have been ordered without consideration of the consequences it may have at the construction site (Dubois et al., 2019). The unoptimized management of deliveries and materials cause craftsmen to spend around 15% of their workday searching, collecting, or moving around materials (Sezer and Fredriksson, 2021). The material movements does not only waste time, but also leads to that materials disappear or get damaged prior to use (Dubois et al., 2019).

Along with an increased interest in construction logistics, more and more Scandinavian site managers have changed their perception towards acknowledge on-site materials handling as a supportive process (Lindén and Josephson, 2013). A process that requires planning and should be performed by specialists while craftsmen solely focus on value-adding tasks (Lindén and Josephson, 2013). Consequently, the interest in outsourcing logistics activities has increased (Lindén and Josephson, 2013), making the use of a TPL-provider more common. Previous studies have also shown that TPL arrangements enable a more efficient management of construction logistics (e.g. Ekeskär and Rudberg, 2016; Sundquist et al., 2018).

TPL is still a relatively new approach for actors within the construction sector (Ekeskär and Rudberg, 2016). Hence, there is still a need for further research to gain more knowledge about this phenomenon. Not least to capture its development, but also to understand how the construction sector adapts to the presence of this new actor (Ekeskär and Rudberg, 2016). Previous research mainly concern projects situated in urban areas, or projects with lack of space for storage. This thesis will fill a research gap within TPL by investigating the opposite, i.e., a project situated in a rural area with plenty of space for materials storage. The research was conducted on behalf of a Swedish contractor, who requested an evaluation of the studied case's logistics performance. The TPL-arrangement was not perceived as completely successful and ended earlier than expected.

1.1 Purpose & Research Questions

This study aims to examine how the involved actors experienced the TPL-arrangement in a rural area, including both positive and negative aspects. Since studying TPL in a new context, the thesis will also investigate how the early preparations and the project's prerequisites, i.e., the project's setting and the characteristics of the construction site, have affected the project's logistics outcome. To concretize the aim of this master's thesis, following research questions were constructed:

RQ1: What are the experienced effects of the TPL-arrangement?

RQ2: How have the project's prerequisites affected the TPL set-up?

RQ3: How have the preparations made prior to the implementation affected the outcome of the TPL-arrangement?

1.2 Scope & Delimitation

This master's thesis conducts a single case study of an on-going 2.4 billion SEK hospital-project, located in a rural area in Sweden that comprises a gross area of 65 000 m^2. The project is an extension of a hospital's operating premises, consisting of two new buildings. The construction is a partnering project that started in 2018 and intends to be finished in 2023.

The research aims to evaluate the use of a TPL set-up from the main contractor's, some of the material-intensive subcontractors' and the TPL-provider's perspectives. However, the research does not consider the client, end-users, suppliers nor all subcontractors of the investigated project. Moreover, it is the materials handling on-site and the interface between the off-site and on-site logistics that will be in focus. However, it is not within the scope of the research to consider the reverse logistics, i.e., the material flow out from the construction site.

The study will primarily focus on the time period where the frame complement and installations took place for both buildings. It was perceived as the most critical phase since involving an intense supply of materials and many actors on site. The study does not intend to identify strengths and weaknesses to argue for or against this type of logistics solution. Rather, the findings from this research are expected to be useful to facilitate forthcoming applications of TPL-arrangements. Furthermore, the outcome of this paper is not expected to be a general framework, but the characteristics of the project must be considered before future use of findings.

2
Theory

In the following chapter, the literature findings are presented. Supply chain management and construction logistic are introduced in Section 2.1, followed by third-party logistics in Section 2.2. Thereafter, a more detailed description of the checkpoint-based TPL-arrangement and its operational concerns are presented in section 2.3.

2.1 Supply Chain Management

To deal with the complexity of supply chains, supply chain management has gained an increased interest within research and among businesses. Lambert and Cooper (2000) define it as "*management of multiple relationships across the supply chain*" (p. 1). The supply chain itself can be defined as a network of organizations, which through downstream and upstream linkages are involved in different processes and activities (Lambert and Cooper, 2000). Thus, the supply chain should be perceived as a network of multiple business and relationships rather than a simple chain with one-to-one business-to-business relationships. The chain produces value for customers and other stakeholders in the form of products, services and information (Christopher, 1992; Lambert and Cooper, 2000).

The construction supply chain is characterised by its temporary setting which results in instability, fragmentation and separation between the design and construction phase, where every project is unique in its set-up. Thereby, construction projects are complex, involving many actors, activities and processes that are dependent on each other (Sundquist et al., 2018). The "factory" is set up around a single product, where the object is assembled from the incoming supply of materials (Vrijhoef and Koskela, 2000). These characteristics affect the supply chain (Vrijhoef and Koskela, 2000), whereof supply chain management can help to improve the efficiency (Dubois et al., 2019).

2.1.1 Construction Logistics

Logistics and supply chain management are closely interrelated, whereof both have a significant impact on the project performance (Sullivan et al., 2011). Logistics can be understood as fulfilling the seven rights, presented by Swamidass (2000). Namely, to deliver the right product, in the right quantity, to the right place, at the right time, in the right condition, for the right customer, at the right price. In line with Swamidass (2000), Janné and Rudberg (2022) define construction logistics as "*to deal with supplying the right materials and machinery to the correct customer and construction site to meet the projects' requirements*" (p. 73).

The logistics activities within the construction industry are closely interrelated, but can be divided into three categories, off-site, on-site and the interface in between. Off-site logistics comprise activities such as acquisition, packaging and transport of materials and equipment to the construction site (Dubois et al., 2019). On-site logistics focus on the planning and coordination of the physical flow and logistics activities at the construction site. This comprise activities such as delivery inspections (Dubois et al., 2019), storage and movement of materials, as well as waste management (Sullivan et al., 2011). The interface includes coordination and planning of incoming deliveries, including unloading.

The construction industry is known for its low efficiency and poor performance (Dubois et al., 2019). Some claim that the organization of the industry is the root of the problem, while others claim that it is the supply chain that is the main problem (Dubois et al., 2019). Several authors (e.g. Ekeskär, 2016; Janné and Rudberg, 2022; Sundquist et al., 2018) claim that TPL can be one way to cope with these challenges.

2.2 Third Party Logistics

The TPL-concept originates from the manufacturing industry, where it emerged in the 1980s as a way to improve the efficiency of the supply chain (Premkumar et al., 2021). In the post-war era, the trend towards globalization emerged, and thus, the need for material transport grew. It put more and more pressure on many companies' transportation departments. However, these departments did not possess the required resources to develop logistics expertise, or rather preferred to focus on their core businesses (Premkumar et al., 2021). It awoke the interest in outsourcing logistics activities, which paved the way for pure logistics companies to emerge. This lead to a major restructuring of the entire logistics industry in the mid-1980s (Premkumar et al., 2021).

The TPL-concept created a new business field in the 1990s, and has thereafter evolved into an reliable approach to increase the efficiency of the supply chain (Premkumar et al., 2021). Premkumar et al. (2021) define the concept as "*relationships between interfaces in the supply chains and third-party logistics providers which are mutually beneficial and where logistics services are offered, from basic to customized ones, in a shorter- or longer-term relationship, with the aim of effectiveness and efficiency*" (p. 553). According to Maloni and Carter (2006), there are three particular reasons why companies choose to outsource their logistics activities. It enables:

(1) Cost reductions due to the TPL-provider's expertise and enabling of economics of scale.

(2) Service improvements by the TPL-provider's efficiency and pure logistics focus.

(3) The company to focus on their core business.

2.2.1 Third Party Logistics in the Construction Industry

In the construction industry, the application of a TPL-arrangement is a fairly new phenomenon (Ekeskär and Rudberg, 2016; Janné and Rudberg, 2022). Not only for contractors and clients, but also for the TPL-providers which traditionally have not served within the construction industry (Ekeskär and Rudberg, 2016). Contractors' and clients' increased interest but limited knowledge in SCM and logistics (Thunberg, 2013) has paved the way for TPL-providers to increasingly appear at the construction industry market (Ekeskär, 2016). In accordance with Maloni and Carter (2006), this new actor is procured due to its expertise rather than that the role itself fulfills any purpose on its own (Ekeskär, 2016).

Instead of providing for instance transport and warehouse functions separately, a TPL-provider offers multiple logistics related services (Selviaridis and Spring, 2007). Ekeskär (2016) and Agapiou et al. (1998) identify several types of services that a TPL-provider can offer, which includes but is not limited to:

(1) Transports, to, from and within the construction site.

(2) Information-related activities, e.g., coordination of activities, organization of waste disposal, providing and updating distribution and delivery plans and tracking materials.

(3) Warehousing, e.g., to provide and manage a CCC.

(4) Inventory management, such as materials handling, repacking and quality inspections of incoming deliveries.

(5) Value-adding activities, e.g., assembly and installation of products.

(6) Design and reconstruction of the construction supply chain, e.g., the TPL-provider can offer expertise.

The implementation of a TPL-arrangement will challenge established professional roles, practices, responsibilities, collaborations and interactions (Ekeskär and Rudberg, 2016; Karrbom Gustavsson, 2018). Thus, various configurations for TPL-arrangements have emerged based on the characteristics of the construction setting and the involved professional categorizes of the project's logistics activities, e.g., TPL-providers, transport and material suppliers, clients, and contractors (Ekeskär, 2016). However, two TPL-arrangements are particularly common, the terminal- and the checkpoint-based (Janné and Rudberg, 2022). Both these configurations focus on decreasing the disruptions at the construction site, but they attain this goal by using different approaches (Janné and Rudberg, 2022).

The terminal based solution, also called CCC, has primarily been used in dense urban areas and focuses on reducing the number of trucks arriving to the site (Dubois et al., 2019). In advance of delivery, goods are consolidated in a terminal located in the vicinity of the construction site, which also enables logistics services such as short-term storage (Dubois et al., 2019). The checkpoint-based solution has generally been applied in complex projects with limited space for storage. It focuses on improving the on-site efficiency by increased coordination and control of on-site logistics activities as well as incoming deliveries, commonly applying a JIT-approach (Dubois et al., 2019). Thus, as noted by Janné and Rudberg (2022), with a checkpoint-based TPL-arrangement, the number of deliveries might not decrease, but if successfully implemented, they will not disrupt nor hamper other activities (Dubois et al., 2019). This research will focus on the checkpoint-based TPL-arrangement, as it is the applied approach in the studied project.

2.3 A Checkpoint-based TPL-arrangement

In a checkpoint-based TPL-arrangement, deliveries are commonly assigned specific time slots and are expected to follow strict regulations to increase the supply chain's efficiency (Dubois et al., 2019). The regulations may for instance concern packaging, labelling and the amount of allowed material to store at the construction site and decreases the risk that the construction project interfere with surrounding businesses (Ekeskär and Rudberg, 2016). Deliveries may also arrive in packages customized for, e.g. the assembly of an apartment (Dubois et al., 2019). The checkpoint also establishes a clear interface between the construction site and its supply chain (Ekeskär and Rudberg, 2016).

A checkpoint-based TPL-arrangement commonly involves the recruitment of an external logistics actor specialized in on-site logistics (Dubois et al., 2019; Ekeskär and Rudberg, 2016). This external actor is usually responsible for the development and management of the site disposition plan, the management and coordination of the deliveries and the inbound materials handling (Dubois et al., 2019). Thus, to utilize a TPL-arrangement does not only have potential to optimize the on-site logistics activities, but can also enable other project members to focus on their competences since the TPL-provider take care of the on-site logistics (Ekeskär and Rudberg, 2016; Dubois et al., 2019).

When deliveries arrive, they are usually moved immediately to their assembly points to minimize the risk of damage (Dubois et al., 2019). The on-site materials handling is mainly performed by personnel from the TPL-provider, enabling construction workers to solely focus on their value-adding tasks (Ekeskär and Rudberg, 2016; Dubois et al., 2019). This has potential to increase the production pace, and thereby impact the project's time plan positively (Ekeskär and Rudberg, 2016). According to Lindén and Josephson (2013), a well-planned logistics set-up can reduce the total production costs by approximately 20%.

A checkpoint-based TPL-arrangement has also been found to make it easier for drivers to find the right unloading zone, resulting in a better followed delivery schedule (Ekeskär and Rudberg, 2016). Furthermore, it has also been proven that the regulations and routines for materials storage and handling carried out by a TPL-provider can result in a better work environment. This since it for instance contributes to less stressful working conditions, and a more optimized and clean physical layout (Ekeskär and Rudberg, 2016).

2.3.1 Operational Concerns

To get any effect, this logistics set-up and its joint coordination presumes that contractors and subcontractors follow a more standardized manner to perform the logistics activities (Dubois et al., 2019). For instance, the solution requires the use of a joint information system for the planning of deliveries, unloading and other activities connected to materials handling. Consequently, Ekeskär and Rudberg (2016) have found that a TPL-provider's IT-capabilities and IT-system could work as a driving force to use a TPL-arrangement. However, a bad experience of the IT-systems could likewise been reported as a significant concern (Ekeskär and Rudberg, 2016).

To reach its full potential, the logistics set-up requires contractors to keep a several days ahead planning and that the logistics manager gets informed about possible changes (Dubois et al., 2019). According to Ekeskär and Rudberg (2016), unexpected deliveries could severely affect the performance of the TPL-arrangement. This since it forces the TPL-provider to do firefighting instead of creating the best conditions for an efficient supply chain. Also, the planning and purchase of materials may become more complicated for contractors. This since they need to make sure that suppliers are informed and comply with the set requirements.

In addition, Ekeskär and Rudberg (2016) have found that a TPL-arrangement should be accounted for in the early planning of a project to establish conditions that enable contractors to keep time frames and budgets. Otherwise, unrealistic objectives and expectations may be set due to inexperience of working with a TPL-arrangement. Furthermore, application of a new logistics setting usually arises fear of, for instance, loss of control, inadequate expertise among the TPL-provider and its employees, or that the craftsmen's tasks become too monotonous (Ekeskär and Rudberg, 2016). This is usually linked to how actors responds to change, which will be further discussed later in this subsection.

Negative Attitudes and Tension

When studying the employment of a TPL-provider in a large hospital project, Ekeskär and Rudberg (2016) discovered that many negative attitudes arose both among suppliers and employees at the construction site. For instance, the contractors perceived the regulations as too fixed and had unrealistic expectations of the possibility to make changes in the set schedules and time frames (Ekeskär and Rudberg, 2016). Also Janné and Rudberg (2022) addressed skepticism and lack of understanding as main challenges when applying a TPL-arrangement in a large office project. The authors found several examples where contractors and suppliers deviated from the set restrictions for packaging, transport, and on-site handling of materials, as well as ignored to post all necessary information in the applied planning system.

Dubois et al. (2019) discovered that the checkpoint-based TPL-arrangement sets an increased demand on suppliers to adjust their services to the on-site logistics. This may cause both extra work and costs due to the need of more frequent deliveries, smaller delivery batches, and of keeping more material in their own storage to handle the construction project's discontinuous demand at a short notice (Dubois et al., 2019). In accordance, Ekeskär and Rudberg (2016) identified that the dissatisfaction among suppliers was strongly linked to inexperience. They were not used to the increased requirement to follow specific delivery time slots and that these deliveries could take place after regular working hours. Furthermore, the suppliers did not expect that such high level of adoption to the constructor's work pace would be required (Ekeskär and Rudberg, 2016).

Among employees at the hospital's construction site, a distrust towards the new actor's ability to handle "*special kinds of deliveries, emergency circumstances and their ability to perform the work in the way the contractors want*" was also encountered (Ekeskär and Rudberg, 2016, p. 187). Skepticism towards the logistics personnel's knowledge in construction was also addressed by Karrbom Gustavsson (2018) when studying a TPL-arrangement. One of the project's contractors expressed that "*They didn't understand the overall idea of how we build [...], the industry is rather conservative, and these kinds of changes make people irritated [...]*" (Karrbom Gustavsson, 2018, p. 605). That the contractor commented the logistics provider's competence, Karrbom Gustavsson (2018) did not consider happened out of coincidence. Rather, it is a strategy an actor embraces to handle an imposed change, which in this case implied a logistics specialist challenging the situated practices of a construction organization.

Causes of Resistance

Karrbom Gustavsson (2018) has identified several reasons why TPL-providers triggers resistance. The role is not only a boundary breaker of established positions and roles within construction organizations. According to Karrbom Gustavsson (2018), the actor also challenges industry norms and practices by introducing new ways of working. It results in changes, or what affected actors may interpret as disturbances, that may cause irritation and tension (Karrbom Gustavsson, 2018).

According to Löwstedt and Sandberg (2020), the people-level impact on standardization in construction has been overlooked within research far too long. It has, not least, been overshadowed by the focus on productivity and profitability. Löwstedt and Sandberg (2020) emphasize that the initiation of more standardized work cannot be separated from the involved professions. This since changes in the way of working will inevitably affect involved professional roles in terms of what services they are supposed to perform, what knowledge they are expected to possess and how they perceive themselves. In other words, a change in how work is performed and distributed at a construction site will over time lead to changes in three cornerstones of a professional role, namely its work, its expertise and its identity (Löwstedt and Sandberg, 2020).

As an example, site managers has for a long time been expected to maneuver the heterogeneity and uncertainties that characterize the daily construction industry's operations (Löwstedt and Sandberg, 2020). Consequently, this role has traditionally been free and independent as long as being well-performing. These characteristics can probably be applied to many other professions in the construction industry as well (Löwstedt and Sandberg, 2020). Thus, by highlighting the dependency within the supply chain and aiming for a high degree of coordination and standardization, the TPL-arrangement may simultaneously challenge several professional roles in the construction sector. Löwstedt and Sandberg (2020) found that it may not even exist any distinct obstacles that makes a site manager reject the use of standardized principles, but it may not be accepted due to how these restrict the role's control of the site. Thus, to impose such principles may result in that site managers start to refuse taking the full responsibility of the construction site. However, according to Dubois et al. (2019), lack of joint coordination in the supply chain can also create tension. Because, if contractors are only following their own" *best practices*" in how to manage their deliveries, clashes may arise if various contractors' different supply strategies cannot co-exist without interfering with each other.

Furthermore, Janné and Rudberg (2022) addressed that the negative attitudes towards a TPL-provider may be caused by a lack of maturity in SCM and logistics. In addition, as floating between boundaries, this new professional role can also get caught in the borderland of being seen as an insider or outsider of a project. Consequently, project members can treat them as one in the team during success, but as an outsider when implemented changes are mistrusted or dysfunctional Karrbom Gustavsson (2018).

Managing Resistance

To overcome resistance, Karrbom Gustavsson (2018) emphasizes the importance of interpreting associated changes as dynamic and continuous. Thus, the evolvement of this logistics set-up should be understood and treated according to the fact that it takes place on a day-to-day basis within the mundane construction operations' efforts and challenges (Karrbom Gustavsson, 2018). In a similar manner, Janné and Rudberg (2022) emphasize the importance of patience, since it will take time to obtain the full potential of a TPL-arrangement.

For a more efficient and painless transformation to standardized principles, Löwstedt and Sandberg (2020) advocate that the top-down and bottom-up viewpoint must be better aligned. That means, the visions and expectations of a standardization initiative should take professional workers' reality into better consideration before the implementation. According to Löwstedt and Sandberg (2020), it is not only the impact of a standardization in itself that need to be regarded, but also its impact on responsibility and control over the production. So far, site managers are for instance considered to be insufficiently involved, however, if that changes it could probably make initiatives for standardization both more legitimate and applicable (Löwstedt and Sandberg, 2020). In addition, Ford and Ford (2010) emphasize that who people make objections towards change are often too fast labelled as resistors and their opinions dismissed as resistance. However, if paying more attention to the negative feedback, instead of blaming it to cause the challenges associated with a change, Ford and Ford (2010) anticipate the process of planning and implementing a change could become cheaper, smoother and more efficient. This since an improved dialogue, that welcomes employees' engagement and commitment, could improve the organizational plans and strategies coherence to its workers realities (Ford and Ford, 2010).

Similarly, both Karrbom Gustavsson (2018) and Janné and Rudberg (2022) call for a better dialogue among supply members. The establishment of good communication may result in that involved actors, not least subcontractors and suppliers, gain a better understanding for the purpose of the TPL-arrangement and why it is important to follow the set rules and policies (Janné and Rudberg, 2022). Karrbom Gustavsson (2018) adds that it may also be a good idea for a project that employs a TPL-provider to initiate dialogues with other projects that use the approach or actors with prior experience. These cross-border discussions increase the probability that lessons learned in practice are transferred between organizational projects, to eventually become anchored within the company (Karrbom Gustavsson, 2018).

3

Method

The following chapter begins by describing the underlying strategy adopted in this research. Thereafter, the research design is presented, including description of how the literature review and the empirical study were conducted. The chapter also discusses the quality assurance of the master's thesis, before addressing the ethical and environmental considerations that has been taken into account throughout the research.

3.1 Research Strategy

This master's thesis linked theoretical and empirical data by using an abductive research strategy. Thereby, the study was explorative in its nature, and focused primarily on understanding (Dubois and Gadde, 2002). That means, the research's focal point was to analyze the main reasons behind experienced concerns when implementing a TPL-arrangement. Thus, by applying an abductive research process the authors perceived theoretical and empirical findings to complement each other. Therefore, both types of data were collected in parallel using a back-and-forth principle (Bell et al., 2019).

This research adopted a qualitative methodology to retrieve data. Hence, the literature review only covered the most relevant academic contributions (Bell et al., 2019). The selection was based on the relevance to the characteristics of the empirical case and the findings made in the empirical study. The empirical study was also qualitative in its nature, where data was collected by conducting semi-structured interviews with open-ended questions. Furthermore, the empirical study was qualitative in the sense that the authors throughout the interviews were open-minded to that it exists multiple truths, i.e., that all involved actors will construct their own realities.

3.2 Research Design

The data collection was conducted in alignment with the abductive strategy described in Section 3.1. Consequently, the literature review, empirical study and analysis were executed in parallel using an iterative process, as illustrated in Figure 3.1. The literature review and the initial study of the case formed a basis for the interview questions used in the empirical study. In addition, the questions were further elaborated and adjusted throughout the research process based on new insights from earlier interviews, and were also to some extent adapted to the role of the interviewees. The empirical data is presented in Chapter 4, where the structure does not follow the RQ:s as Chapter 5 and 6. This since the semi-conducted interviews allowed the interviewees to speak freely, whereof several RQ:s were discussed at the same time, making it difficult to distinguish where to put the data. Instead, the empirical data was compiled by categorizing the findings according to common themes that were identified during the interviews.

Lastly, the finalization included an analysis and conclusion. The analysis comprised discussing topics connected to the research questions. The conclusion included answering the research questions, discussing proposals for future projects, as well as stating the thesis' research contribution, limitations and considerations for future research.

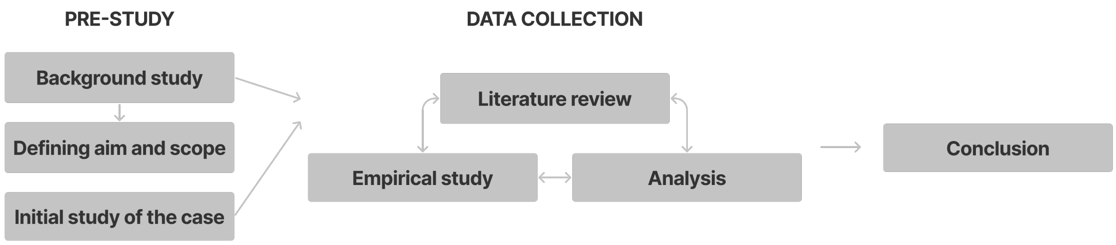

Figure 3.1: Research Process (Authors' own figure)

3.2.1 Literature Review

To review and engage in existing literature is one of the most crucial elements of a research study (Bell et al., 2019). To engage in prior academic contributions helps the authors to gain a broader and more accurate understanding of the current state within a research field. It may also inspire the authors to consider a larger number of aspects within their research topic, such as new methods and theories, which otherwise may not have been thought of (Bell et al., 2019). Knowledge of prior research also prevents the authors to repeat other researchers' mistakes and to rediscover what is already known. Likewise, studying existing research contributes to an insight of what is still undiscovered, and thus, may also be a way of finding new research issues that could be deeper investigated (Bell et al., 2019).

To accomplish the purpose, the literature review began at an early stage of this research. To ensure relevance, literature was initially collected and studied in parallel with reviewing documents and other written data connected to the TPL-arrangement in the studied case. The study has aimed to only retrieve literary data from conference papers, scientific articles and books within relevant scientific fields. The literature was mainly retrieved from the two research engines Google Scholar and Chalmers Library, using keywords such as TPL, 3PL, construction industry, third party logistics, logistics outsourcing and Sweden in different combinations. Literature has also been retrieved from the list of recommended readings in the courses ACE130 Construction Logistics and Supply Chain Management provided by Victoria Sundquist at Chalmers during fall 2021, and TEK660 Managing Change in the Construction Industry provided by Pernilla Glüch at Chalmers during spring 2021.

In addition, a literature review is a helpful tool to interpret and understand the meaning of empirical findings, to prove the significance of findings, as well as a tool that strengthens the reliability of the statements made within one's own research (Bell et al., 2019). Therefore, in accordance with an abductive strategy, data was in the middle and later stages of the study collected using an iterative process. Thus, when the empirical study contributed with new insights, the context of the theory was adjusted to remain relevant.

3.2.2 Empirical Study

According to Easterby-Smith et al. (2015), interviews are claimed to be the best way to gather empirical data. It enables researchers to access information of phenomenons that otherwise is difficult to observe (Easterby-Smith et al., 2015). Furthermore, semi-constructed interviews are a form of qualitative interviews which put greater emphasis on the interviewee's own perception and point of view (Bell et al., 2019; Easterby-Smith et al., 2015). Thereby it enables more fruitful and detailed answers in comparison with structured interviews (Bell et al., 2019). This form of interviews enables flexibility (Easterby-Smith et al., 2015) since it allows interviewees to elaborate their answers and interviewers to ask follow-up questions.

Accordingly, this research's empirical study consisted mainly of semi-constructed interviews and a site visit. Additionally, the main contractor also provided project documents developed for the case's logistics set-up. The interviews were conducted to gain a deeper understanding of the studied case and its associated logistics solution from different points of views. Several actors were interviewed to get a broad picture of these issues. In total, 17 interviews were conducted, whereof Table 3.1 provides a short description of the interviewed actors, including their professional roles and type of company.

The interviewees were selected and contacted in dialogue with the supervisor at the case company. The interviews with the main contractor included actors central in the organization, such as purchasing manager, project managers and calculator. It also included people working at the site, such as site managers, supervisors and a machine driver. The interviewed subcontractors were foremen and project managers from ventilation-, electricity-, and plumbing firms. The chosen subcontractors were those who received most deliveries during the project, whereof the interviews with company 2, 4 and 5 were held as group interviews. This was to capture not only the perspective of the project managers, but also the foremen who were more involved in the daily production. From the TPL-provider, the business manager, logistics manager, delivery recipient and the project manager were interviewed.

Table 3.1: Interview overview

Interviewee	Short	Role description
Main Contractor		
Representative 1	MC1	Calculator / Project Manager
Representative 2	MC2	Machine Driver
Representative 3	MC3	Block Manager
Representative 4	MC4	Purchasing Manager / Initiator of TPL-arrangement
Representative 5	MC5	Site Manager 1
Representative 6	MC6	Site Manager 2
Representative 7	MC7	Supervisor 1
Representative 8	MC8	Supervisor 2
Subcontractors		
Company 1	SC1	Project Manager, Plumbing Company
Company 2	SC2	Project Managers and Foremen, Ventilation Company
Company 3	SC3	Project Manager, Ventilation Company
Company 4	SC4	Project Manager and Supervisors, Electricity Company
Company 5	SC5	Project Manager and Foremen, Electricity Company
TPL-Provider		
Representative 1	TPL1	Business Manager
Representative 2	TPL2	Delivery Recipient
Representative 3	TPL3	Logistics Manager
Representative 4	TPL4	Project Manager

Table 3.2 describes the interviewed companies' yearly turnover 2020 to give a picture of their sizes. To make it more difficult to identify the companies, four turnover categories were constructed. C1 implies a yearly turnover below 1,250 MSEK, C2 between 1,250 and 3,750 MSEK, C3 between 3,750 and 5,000 MSEK and C4 above 5,000 MSEK. This data was retrieved from Allabolag (nd).

Moreover, to enable time for a large sample size of interviews, most interviews were held digitally in the software Teams. It was also perceived as more appropriate since the study was conducted during the Covid-19 pandemic.

Table 3.2: The interviewed companies' yearly turnover 2020 Allabolag (nd)

	Yearly Turnover (MSEK)			
Company	C1	C2	C3	C4
Main Contractor		X		
Subcontractor 1	X			
Subcontractor 2	X			
Subcontractor 3				X
Subcontractor 4			X	
Subcontractor 5	X			
TPL-provider	X			

According to Bell et al. (2019), one of the challenges with a qualitative research is that it derives a large amount of data, and thereby requires a significant amount of time to interpret. In this study, content analysis was used to interpret the data gained from the interviews. This technique analyzes a text‘s content through a systematic classification process, which involves coding and identification of themes and patterns (Hsieh and Shannon, 2005). This thesis used a conventional content analysis to analyze data, which implies that coding categories are directly derived from text data, which is done by highlighting parts of the texts and then linking them together (Hsieh and Shannon, 2005). This method was used to identify common themes in interviewees' responses. The approach was a vital tool for the research to identify challenges and useful insights deriving from practical experiences.

3.3 Quality Assurance

The way the authors approached this research and managed its compiled data was vital for the overall quality and usefulness of the study's findings (Easterby-Smith et al., 2015). A well-conducted study is, according to Easterby-Smith et al. (2015), systematic and thorough, both regarding the collection of theoretical as well as empirical data.

To ensure the trustworthiness and authenticity of any qualitative research, several criteria must be taken into consideration (Bell et al., 2019). Trustworthiness addresses the importance of four criteria: credibility, transferability, dependability, and confirmability. The following subsections describes how these criteria were dealt with in this research. Thereafter, the significance of authenticity and ethical consideration are discussed.

3.3.1 Credibility

Credibility comprises that the research has been carried out in an appropriate manner, i.e., establishes reliance and acceptance of the research's outcome among the readers (Bell et al., 2019). In this research, triangulation was applied to enhance the credibility of the qualitative data. Triangulation implies cross-checking findings from different data sources, data collecting methods as well as types of data (Bell et al., 2019; Easterby-Smith et al., 2015). Thus, to strengthen the research's findings, this study has cross-checked data from the interviews with literature findings.

Furthermore, credibility places responsibility on researchers to confirm that their interpretation of the responders' reality is correct (Bell et al., 2019). Therefore, all interviewees were offered to read their transcriptions. This validation allowed confirmation as well as correction of misinterpretations, and thus, contributed to that an accurate and fair picture of the interviewees' reality has been captured. However, when evaluating collected data from interviews, it should still not be underestimated nor neglected that a interviewee may be biased, which is another reason for this research's use of a triangulation technique.

The selection of papers for the literature review has also continuously been critically assessed. Publish date, type of resource, addressed context, and the relevancy of findings were critical parameters.

3.3.2 Transferability, Dependability & Confirmability

Transferability addresses to what degree the research findings can be applied to other settings and contexts (Bell et al., 2019). Since being oriented to a specific case, i.e., studying the logistics of a single construction project, the result of this research may be considered as too dependent and biased towards the set context to fairly represent the reality for the entire construction industry. Consequently, the generalizability of this research was deprived to some degree. However, to facilitate transferability, the authors strived to present a robust and detailed description of the addressed case and its circumstances. Thereby, according to Bell et al. (2019), the authors helped their readers to assess in what circumstances the study's outcomes may be applicable.

Furthermore, dependability addresses how likely it is that the research can be conducted at other times (Bell et al., 2019). According to Bell et al. (2019), this can be ensured by adopting an auditing approach that in an accessible form comprises complete records of all phases of the research process. Therefore, the research has clearly described its research process in the paper. In addition, discussions about the research method has been held during a peer review, which also strengthens that the research has been conducted in an appropriate manner.

In addition, auditing of the study by both peer reviewers and the examiner in the early as well as the later phase of the research helped to ensure that an open mindset was kept during the data collection and analysis. These evaluations are seen to reinforce the confirmability of the research, which according to Bell et al. (2019) refers to the objectiveness of the authors. However, since the authors spent time writing on the main contractor's office, it is possible that the report has been affected. Spending time at the office has contributed positively by gaining a good perception for how the organization functions, but since getting to know its personnel, it may have affected the critical thinking towards the organization.

3.3.3 Authenticity & Ethical Consideration

Beyond the criteria of trustworthiness, authenticity comprises aspects such as fairness to a wider extent. Fairness concerns stressing the authors' responsibility to assure that the study fairly represents more than one actor's viewpoint of the subject within the addressed social setting (Bell et al., 2019). Thus, authenticity emphasizes the importance of a nuanced study. Hence, this study did not only capture the main contractor's perspective of the TPL-arrangement, but also the TPL-provider's and the subcontractors'.

According to Bell et al. (2019), several issues connected to ethics can arise in the different phases of the research process. These issues are crucial to be aware of to ensure the integrity of the study. Several significant elements of ethics have already been covered in the section about trustworthiness and authenticity, such as fairness and prevention from being biased. However, there are still some key elements that need further attention. To begin with, as this study included interviews, several critical aspects need to be taken into consideration to assure that the research participants are protected (Easterby-Smith et al., 2015). To protect the interviewees, their names were anonymized and only their professional title and type of company was revealed. This was also done to enhance the possibility to speak freely without risking any consequences for the respondents.

Before the interviews, it was asked for permission to record the interviews. Furthermore, it is according to Bell et al. (2019) important that the researchers are transparent about the aim of the study. Thereby, the aim of the study was described in the beginning of each interview. To make sure that the interviewees' answers were interpreted correctly, the interviewees were provided with their transcriptions afterwards and had the possibility to remark if something was incorrect.

Since this study was executed on behalf of a company, deception should also be prevented (Bell et al., 2019). To prevent deception, a planning report was approved by both the supervisor at the case company and Chalmers before beginning the research. Furthermore, a continuous dialogue was held with both supervisors, throughout the research.

3.3.4 Environmental Consideration

The building and construction industry's emissions stands for 37% of the world's energy related carbon dioxide emissions each year (IEA, 2021). The extraction of materials, manufacturing of products and components, construction, renovation, and demolition accounts for approximately 5-12% of the greenhouse gas emissions released during a building's life cycle (Bertin et al., 2022). The construction sector is also a major contributor to the the world's generation of waste. For instance, in 2020, the construction operations generated about 25-30% of the total waste in EU (Muerza and Guerlain, 2021). In addition, the construction industry's transports have been reported as a major contributor to greenhouse gas emissions (Sezer and Fredriksson, 2021). For instance, Sezer and Fredriksson (2020) have stated that the transports of a construction project accounts for approximately 10% of the total CO_2 emissions released during the production of a construction project.

Consequently, to reduce the number of delivery trucks queuing outside a construction site, and to decrease the amount of material waste at a construction site can contribute to essential environmental savings. A successful TPL-arrangement can both improve the coordination of trucks entering a construction site, as well as streamline and reduce the risk of poor materials handling at the construction sites (Dubois et al., 2019). Hence, it possess great potential to reduce a construction project's carbon dioxide emissions, as well as save resources in terms of time, money, materials and deliveries. Thus, by addressing the development and how to enhance a TPL-application, this master's thesis aims to contribute to both environmental and economical sustainability.

4
Empirical Findings

In this chapter, the empirical findings are compiled and presented. Section 4.1 describes the empirical case and how the TPL-arrangement was initiated. Thereafter, 4.2 describes how the solution was implemented in production, before this and following sections address how the interviewed actors' experienced the set-up. The chapter can be interpreted as a pre-analysis since people's opinions have been grouped, mainly according to what department and professional category they belonged to. However, a more profound analysis is presented in Chapter 5.

4.1 Background to the Empirical Case

In 2018, during the preparations for the hospital expansion, it was realized that the construction logistics would become a complex issue. The project would not only consist of two material-intensive buildings, a psychiatry and an emergency department, but these would also to a great extent be built in parallel. In addition, the two departments would be assigned their own project management team, as illustrated in Figure 4.2. For several professional groups, the employed company would also differ between the two departments. Consequently, the project was expected to involve a lot of actors, and an intense and fragmented supply of materials. Approximately 45 000 deliveries were expected in total.

The frame complement and installation phase was foreseen to be the most critical period. Thus, prior to this production stage, it was decided that the the logistics operations would be outsourced. This to enable a more streamlined production with less interruptions. Thereby, an improved control and coordination of the logistics activities was expected, and more of craftsmen's and project managers' time was expected to be spent on production activities.

Furthermore, the construction site was situated next to the existing hospital, as illustrated in Figure 4.1. The hospital would continue to run its business as usual throughout the entire production phase. However, the project would include a lot of space and have its own road. Thereby, the construction was not expected to affect the hospital's traffic or activities. Hence, the closeness to a hospital was not expected to be the project's most critical logistics challenge.

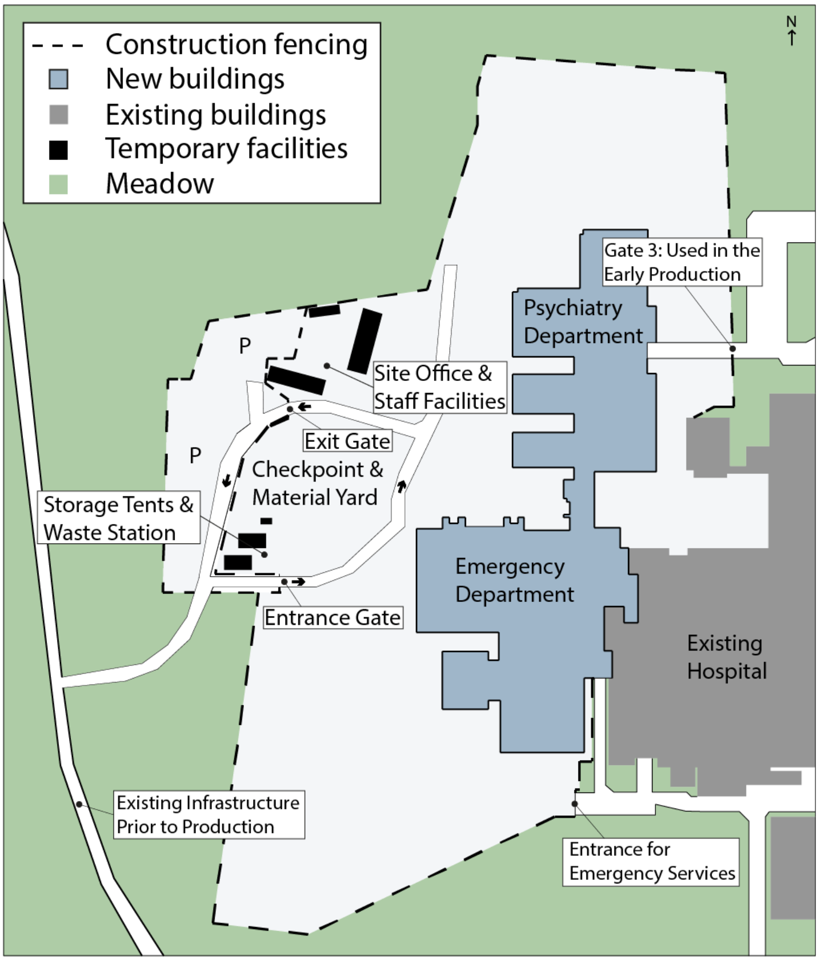

Figure 4.1: Illustration of the site for the studied case (based on material provided by case company)

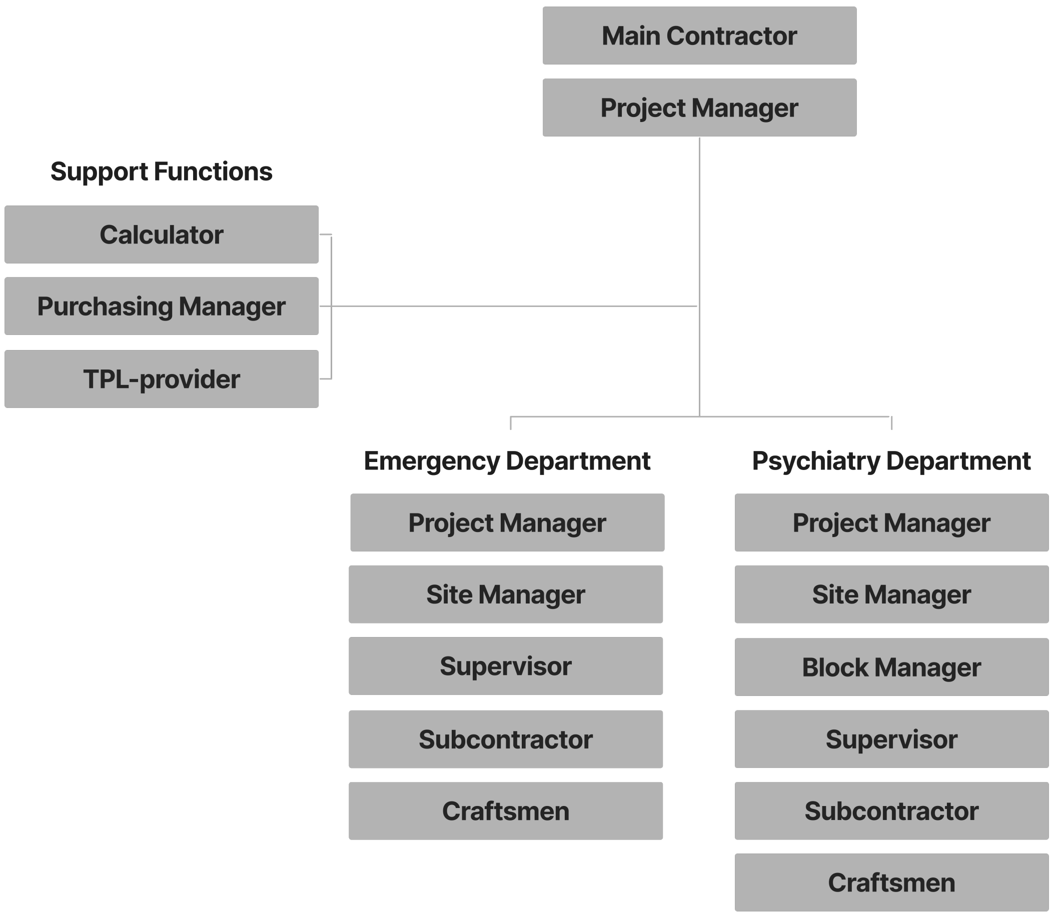

Figure 4.2: Project organisation in the studied case (based on material provided by case company)

4.1.1 Earlier Experience

None of the project's involved actors had much previous experience of TPL. However, MC4 had experience of procuring a TPL-provider in a large project in Gothenburg. Thereby, MC4 had gained insight in how to create documents for a TPL-arrangement, such as what processes to include and how to prepare the budget. Furthermore, some of the interviewees from the main contractor had earlier worked as logistics workers, or had friends who worked with it during their studies.

In addition, some of the main contractor's project managers had experience of applying light versions of the logistics concept. For instance, some had earlier used time-fixed deliveries and package services, where the supplier delivered, pulled in, and installed its products. Thus, the concept was not completely new for the main contractor's personnel, although they lacked practical experience. Also, a few subcontractors had similar experiences of package solutions.

According to TPL1, the TPL-provider has in the past generally been hired for large projects, such as development of urban areas or complex buildings containing several functions. These projects have usually been located in larger cities with lack of space for storage. The TPL-provider has mainly operated in projects with a minimum budget of half a billion SEK, but have lately expanded their business to also operate in smaller projects. Prior to this project, TPL3 had no experience of projects with a lot of space nor of projects located in rural areas. TPL3 had rather worked with logistics planning in the Stockholm region. Furthermore, TPL2 had no prior experience of working in construction. However, TPL2 had earlier worked as a driver and had thereby delivered to construction sites.

4.1.2 Anchoring the TPL-arrangement

Despite that the involved actors had limited experience of the TPL, TPL1 stated that they from the beginning showed a great interest in the solution. This with a driven person in charge from the main contractor. Furthermore, TPL1 stated that they received the support and commitment they wanted, and that the main contractor had a clear picture of what they expected from them. To anchor the TPL-arrangement in the project, MC4 presented the idea during a purchasing meeting. This was done before deciding whether to adopt the solution or not, with participants from all contractors present. Cost estimations were presented, whereof it was found that an improved production efficiency of 7% would result in that they would break even financially. During the initial purchasing meetings it was also addressed how the logistics set-up was intended to work in theory, such as what roles to recruit and the price setting of the TPL-services.

MC4 perceived that everyone was convinced to use the solution. All contractors agreed to transfer the expected logistics costs from their budgets to a joint one that would finance the TPL-arrangement. However, even though the majority of actors seemed to accept the idea, MC4 noticed at an early stage that some craftsmen possessed certain fears. Mainly, it was linked to that they no longer would be able to rotate between work tasks. Furthermore, some of the craftsmen also felt that this new actor would steal their tasks. These concerns were according to MC4 met by clarifying that no one would be forced to use logistics workers for the inbound materials flow. However, the intention was that the professional workers would not perform the logistics tasks themselves.

4.2 Implementation in Production

The logistics set-up originated from the TPL-provider's established logistics model, with adjustments made for the specific project. The project's logistics chain is visualized in Figure 4.3, whereof the TPL-provider's liability included the four latter logistics services, i.e., the checkpoint, the storage tents, the inbound materials flow and the waste disposal. Furthermore, the TPL-provider's responsibility included the overall planning and coordination of deliveries and logistics activities, including the design of the site layout for the logistics functions.

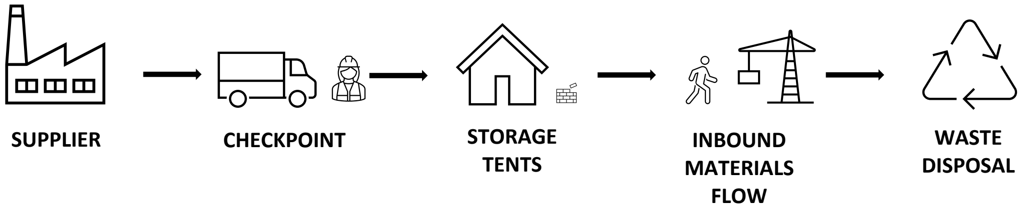

Figure 4.3: Logistics set-up in the studied case (based on material provided by case company)

The TPL-provider's liabilities were divided between a logistics manager, a delivery recipient and logistics workers. The logistics manager was responsible for the coordination of the overall logistics, to ensure that the set logistics restrictions were maintained, and acted as contact person towards the contractors and suppliers. This work involved for instance administration of the delivery planning system, to manage emerging issues related to the on-site logistics, as well as to prepare the construction site and allocate enough equipment and logistics workers for the inbound materials flow. Furthermore, the role attended and arranged various logistics meetings with contractors and suppliers, and supervised the delivery recipient.

The delivery recipient was situated at the checkpoint, located by the site's main gate. Besides receiving all incoming delivery trucks, the delivery recipient was assigned to follow up how well the delivery schedule was followed, unloading the trucks, and to take incoming phone calls from drivers. When deliveries arrived to the site, a visual inspection was conducted, which involved comparing the number of pallets or packages with the delivery note and to document if any external damage has been observed.

According to TPL2, the majority of the transports arrived in the morning, or at least before lunch. Some materials were directly transferred to specific stations, but the majority of the deliveries were unloaded by the storage tents. Before the logistics workers arrived at 4 pm, materials were moved from the checkpoint to the unloading zones next to the building. Thereafter, the logistics workers were responsible for the inbound materials flow, i.e., to move the materials to the assembly points. This was done after regular working hours, usually between 4 and 8 pm.

4.2.1 General Experience

According to interviewees from the psychiatry department's project management, the general experience of the TPL-arrangement was mainly positive. They experienced that the TPL-provider mastered how to handle the materials, kept track of where they were placed and had a functioning set-up to handle the inbound materials flow. At times, materials have been misplaced or placed so that it obstructed work. However, this was believed to be just as much their own fault, such as due to poor communication or incorrect labeling.

The emergency department's project management had mixed feelings about the TPL-arrangement. It did not reach their expectations, and thus, some of them questioned whether the TPL-arrangement should have been applied in the project at all. MC8 though that the TPL-arrangement entailed a lot of additional work, such as placed a greater burden than expected on the supervisors. Furthermore, it has been stated by several interviewees that the inbound materials flow did not work properly. Also, doubts about the need for someone responsible for the planning of deliveries were raised.

The subcontractors generally considered that the TPL-arrangement worked well, whereof the delivery reception and the inbound materials flow were most appreciated. For instance, a supervisor at SC5 described it as smooth since 90% of the work was already done once the materials are inside the building. Thereby, they could focus on the installations. In addition, according to SC3, the craftsmen started to whimper once the service was removed. They had got used to the service and got a bit spoiled. Nevertheless, shortcomings associated with the internal materials flow was also brought up by most subcontractors. A better handling of the delivery notes were also requested by some of them.

Representatives from the TPL-provider believed that the TPL-arrangement worked well for being the first cooperation with the main contractor. However, since their services were not fully utilized, it did not reach its full potential. A difference in reception and execution was experienced between the two departments, whereof the collaboration with the psychiatry department was perceived as easier. The TPL-provider found it difficult to give an unambiguous reason for this, but rather believed it was a mix of several factors. For instance, differences in size, project management, number of involved actors and personal chemistry were addressed aspects which may have had an impact.

In addition, TPL3 emphasized the importance of reaching out with the information to all involved actors. According to TPL3, the management and the personnel at the office better understood and agreed to the logistics changes, while the craftsmen were not as convinced. TPL3 added that it is usually among the craftsmen that making changes takes time. This since many of them have often been out in the field for long and, therefore, are harder to convince. According to TPL4, it is hard to generalize which profession that usually shows most resistance. Commonly it is the craftsmen, but it can also be a question of age rather than profession. Commonly, younger people are more flexible and open to try the TPL-arrangement. It is also a question of personality, and how people prefer to work. Furthermore, TPL4 experienced a greater resistance among actors in this project compared to an average project, and wished that the solution would have been better anchored internally. Therefore, more time should initially have been spent to get the key persons on board.

Regarding the cooperation with the TPL-provider, many actors were pleased. The TPL-provider's personnel were perceived as cooperative and willing to take feedback. Also TPL3 perceived the cooperation as successful, both the cooperation with the main contractor and the subcontractors. However, TPL3 experienced some resistance among the craftsmen. In accordance, MC1 stated that the main contractor's craftsmen in periods were pretty harsh towards the logistics manager when materials ended up at the wrong place. This issue could however be solved through meetings and dialogues with the involved personnel.

4.2.2 Perception in Production

Several actors from the psychiatry department stated that there were some skepticism at first when implementing the set-up, not least among the craftsmen. MC5 stated that people usually get anxious when new external actors enter a project. Comments like "*How will this turn out?*" and "*Are they once again misplacing things...*" were for instance mentioned by the craftsmen. However, over time, the craftsmen seemed to realize the benefits of the TPL-arrangement. Several other interviewees from the psychiatry department gave a similar picture of the application. For instance, SC4 stated that many were initially sceptical towards the TPL-arrangement. It raised questions such as "*Will it work?*" and "*How will they know how we would like it to be done?*". SC4 also highlighted it to be a great responsibility to allocate someone you do not know. According to SC4, it was not until the first delivery arrived people realized that it could work, when they saw how it turned out in reality.

Over time, once the TPL-arrangement had been adjusted to the project, all contractors within the psychiatry department seemed to agree upon that it overall turned out well. MC5 perceived that the TPL-provider succeeded to adjust the solution to the project over time, and thus, was not perceived as a burden. The emergency department's project management, however, experienced that the attitude towards the TPL-arrangement followed the opposite pattern. MC6 and MC8 described that people were quite positive in the beginning, but that they got a more negative attitude over time. Moreover, MC8 considered the misplacing of materials to be one reason why the TPL-arrangement did not turn out that well.

Also, some subcontractors expressed that the craftsmen thought that it worked mediocre within the emergency department. However, this dissatisfaction may according to SC5 be connected to that there were many senior employees involved, who initially wanted to work as they always have. Furthermore, even though craftsmen were pleased with getting the materials dragged in, they did not appreciate that the service was only provided during evenings. Moreover, some subcontractors also shared quite similar descriptions as the actors within the psychiatry department.

4.2.3 Perception Among the Project Management

According to MC5, the greatest benefit was claimed to be the reduced burden on project managers. For instance, MC5 appreciated that the TPL-provider took care of the personnel recruitment for the logistics workers. Furthermore, the reduced number of phone calls connected to deliveries were especially appreciated. According to MC5, a delivery can require up to ten phone calls before it is at the right place. In this project however, MC5 hardly received any phone calls from drivers, which was considered to save a lot of time. Also, MC3 and MC7 mentioned time savings. According to MC3, if going out on the construction site in a large project, it can take two hours to perform a task because one gets a lot of questions or other chores appear along the way. Thereby, MC3 stated that it saved time when someone else was responsible both for the delivery reception and the materials handling. Similarly, MC6 considered that the solution has reduced the amount of work, in particular administrative work.

However, several interviewees from the main contractor stated that it was hard to measure exactly how much of the project managers' time that was saved due to the decreased phone calls. Furthermore, materials tended to get misplaced, resulting in that foremen and craftsmen still needed to spend time to search for it. In addition, MC6 stated that to bring in inexperienced people at the construction site increased the concern regarding the work environment. According to MC6, the logistics workers went straight up on a scaffolding when they barely knew where to put their feet.

MC2 emphasized that it was an instructive experience to be in a project of this size, where you realize that you cannot always take care of everything by yourself. However, since the inbound materials flow was directed to a few hours in the evening, it made the workload for MC2 intense. Since a lot of material arrive during the day, but the influx was limited to four hours in the evening, MC2 was not sure whether it was worth it. When deliveries arrive in this setting, they must first be unloaded at the checkpoint, and rearranged to be better prepared for the influx in the evening. It resulted in a crowded checkpoint at 2 pm, before intense hours started for the machine drivers to move the materials to the unloading zones by next to the buildings. In addition, the presence of a machine driver was also required during the evening's influx of materials. Thus, the solution was perceived to set high expectations on machine drivers in terms of long and periodically intense work days.

4.2.4 Information Flow

All involved actors expressed that they have felt well-informed and aware of the scope of the TPL-arrangement prior to the application. All interviewees were also aware of the logistics documents. During the project, there have been several different kinds of meetings connected to the TPL-arrangement. After the initial meetings, where the solution was presented, there were a few start-up meetings for affected contractors in the production. During these meetings, the implication of the solution was further presented, such as how to announce upcoming deliveries in the delivery booking system. Since all involved actors had offices in the same building, spontaneous meetings have also occurred throughout the project. These could concern booking of deliveries and different kinds of arising concerns.

It differed a lot between actors and interviewees how the logistics meetings were perceived. Some actors state that they worked well and were efficient, whereas others state that they were more informative in its nature, partly because issues already had been discussed prior to these meetings. Several actors stated that the attendance at the logistics meetings were good in the beginning, but with time, the participation decreased. Thereby, these meetings were mainly replaced by team leader meetings. According to TPL3, most issues were raised during the team leader meetings, and that might be one reason why people did not attend the logistics meetings. For instance, the upcoming week's work was coordinated during the team leader meetings, such as incoming deliveries and the required materials movements. Still, some state that logistics meetings were necessary to have in the beginning, but once people got used to the routines, they were not as useful. In addition, SC2 stated that it would be preferable to have the machine drivers present at the logistics meeting to get their opinions.

During the logistics meetings, the participants were also informed of how well they coped with the booking requirements. This was something several actors did not see as necessary. According to TPL4 however, this was important to reach the goal that all deliveries should be booked 5 days in advance. TPL4 stated that as long as it worked well, you do not have to mention it. Then it is enough to mention it once a month or send it by e-mail, but when it does not work well, you need to have frequent follow-ups. For the TPL-provider, weekly meetings are important to coordinate the incoming deliveries, the material movements and to improve their operations.

4.3 Delivery Restrictions

Following section pays further attention to the delivery requirements. The studied case had delivery restrictions regarding packaging, labeling, and scheduling of deliveries. It was each contractor's responsibility to ensure that their suppliers followed the set delivery restrictions. Several subcontractors found these requirements as challenging. Particularly to make suppliers label their deliveries according to a specifically designed barcode and to follow set time slots were perceived as difficult.

Contractors have mainly tried to get their larger orders to follow the set restrictions, for instance by including the requirements in the purchase agreements, attach the logistics documents in each order, and by more or less nagging the demands. However, for special or urgent orders, actors tended not to follow the set demands. For instance, a subcontractor stated that for some urgent deliveries, the only logistics-related directive that they gave was that the supplier should call when they arrived at the gate.

TPL3 noticed that a large number of smaller, local suppliers were used during the project. However, according to TPL3, no major deviations have arisen because of this. Furthermore, to enhance the compliance with the set restrictions, TPL3 expressed it as successful to invite suppliers and distributors to the construction site. According to TPL1 and TPL3, it is usually helpful for them to gain a better understanding of why a particular logistics set-up is adopted and, thus, it is usually an efficient method to improve the compliance to the set restrictions.

4.3.1 Labelling

According to TPL4, the design of the label was mainly developed by the main contractor. The TPL-provider demanded that it should be clear to which contractor, and where deliveries would be placed in the building. Therefore, the label was expected to include information of who was the sender and receiver, as well as to what building, floor level and frame line a delivery would be delivered. However, according to several interviewees, the chosen design of the delivery label required an increased amount of information compared to an ordinary label. This was pointed out as challenging to fulfil for suppliers, not least by the smaller ones.

As a solution, SC5 asked their supplier to print the location coordinates at a separate paper and attach it to the delivery, instead of trying to fit the information in the ordinary delivery labels. Also, MC8 expressed that the manufacturing industry is very standardized. Thus, for next TPL-application, it might be better to only demand what information that should be attached on deliveries, while the labeling can be designed as it suits.

4.3.2 Package Restrictions

Overall, the package restrictions have not been a major problem in this project. Still, certain types of deliveries, like ventilation systems, had difficulties to reach the set requirements. According to TPL4, it is common that some types of deliveries cannot fulfill the set package restrictions. TPL4 added that there is not a problem to solve these deviations if they are informed in advance. Thereby, a proactive solution can be implemented. An excessive number of unexpected deviating deliveries will however lead to inefficient resource management and consequently, higher costs than predicted.

Also TPL2 experienced the delivery of the ventilation systems as most challenging. These pipes were often packed standing, without wrapping to make full use of a truck. To unload these types of deliveries were therefore perceived as extra challenging since it was easy to buckle the pipes. Furthermore, the pipes were often standing on disposable pallets that easily broke. Furthermore, addressing the use of pallets, TPL2 and MC2 informed that the packaging and quality of pallets have varied a bit. Although the use of EUR pallets was expected to be applied, TPL2 has experienced that disposable pallets sometimes have been used. Also, MC2 announced that pallets have sometimes been placed on the width instead of the length, resulting in that the telescopic loader could not be used to unload the truck. However, even though packaging restrictions were expected to be better followed, MC2 explained that solving these deviations was not perceived as difficult.

4.3.3 Time Slots

Over time, all subcontractors within the emergency department felt that the booking of deliveries ran out of steam, but that there was a good flow anyway since there were plenty of space at the construction site. Also subcontractors from the psychiatry department experienced that their suppliers were not used to adapt to time slots, nor that they were properly followed. According to TPL4, the abundance of space at the site does not have to affect the need for logistics, but might rather create a false sense of security. TPL4 further adds that the problem with space is that once you have it, you will use it. However, it does not necessarily imply that it will be used efficiently.

Several reasons were raised by subcontractors as the underlying cause for the problem of time slots. Among them, one actor had already made many purchases before the TPL-provider entered the project. Purchases for which it was perceived as difficult to put more demand on the supplier due to prior agreements. In the acute quest to find the right products, for instance due the Covid-19 pandemic, actors sometimes felt that it was difficult to put extra logistics demands on the suppliers. Several suppliers also outsourced the transport to distributors, whereof the subcontractor had to contact the distributor directly to set demands on the deliveries. Furthermore, some contractors believed that the number of deliveries remaining for a driver for the rest of the day may had a significant impact. Also, TPL2 stated based on personal experience that these types of requirements tend to be taken with ease among drivers for them to streamline their workday.

4.3.4 Long-Term Planning

The set logistics requirements stated that deliveries should be booked at least five days in advance, and include information such as sender, receiver and delivery characteristics. All contractors found this to be difficult to follow. According to TPL2, smaller deliveries and deliveries from abroad tended to arrive unannounced. In addition, most contractors stated that they did not see the point with assigning and demanding the small deliveries, such as single packages, to follow specific time slots. Some contractors also admitted that they forgot to update the digital booking system when deliveries were delayed. There were also cases when suppliers, in the last minute, announced that they would arrive hours or even days too early. Regardless of reason behind the unforeseen change, interviewees stated that the delivery recipient and the machine drivers managed those situations well.

According to TPL4, it is important that all types of delivery are booked, preferable 5 days in advance. According to TPL4, approximately 80% of the deliveries can be planned 5 days ahead, while the remaining 20% will include changed or acute deliveries. Therefore it is important to book the 80% to make room for the unplanned or rescheduled deliveries. Moreover, TPL4 stated that it is important to book the small deliveries as well, since if these arrive unannounced, it can disturb the incoming larger deliveries. TPL3 also stressed that the workforce and machines are planned based on the bookings in the delivery booking system. Thus, if the deliveries are not booked, the logistics workers will not have time to handle all materials movements.

Furthermore, the applied delivery booking system has been described as user-friendly by most contractors. In addition, some interviewees stated that they appreciated to have the site disposition plan and all logistics documents easily accessible in the system. For instance, it made it more practicable to attach the logistics documents when ordering materials. Thus, it increased the probability that the delivery restrictions were followed. Several contractors also addressed the benefit of having access to a joint schedule when booking deliveries. Likewise, TPL2 appreciated the overview the schedule entailed, although it was not always up to date. However, MC2 considered the schedule to be messy, contain too much information that did not concern a machine driver's work, and lacked the function of receiving a notice shortly before a delivery would arrive.

4.4 The Logistics Model

The TPL-arrangement in the studied project included the five steps presented in Figure 4.2. The following section will in more detail address the concerns related to the three middle steps of this model, i.e. the checkpoint, the storage tents and the inbound materials flow. The first step, deliveries from suppliers, will not be further addressed in this section since it already has been discussed in Section 4.3. The last step, waste disposal, will neither be addressed as it extends beyond the scope of this paper.

To begin with, the logistics manager, who coordinated the logistics activities, has overall been perceived to do a good job. However, doubts about the need for someone responsible for the coordination of deliveries were identified since none has been declined. According to some interviewees within the emergency department's project management, the delivery manager entered the project before the need for logistics services arose. This was done to give the logistics manager good conditions to get to know the project and the personnel on site. However, according to MC1 and MC6, this was not entirely beneficial. To appoint a position before there was much work to perform caused staff to question what the person was actually doing during the days. In addition, staff questioned why they could not have done these tasks themselves. Also, MC1 added that it may be a question of pride, adding fuel for this resistance to arise.

4.4.1 Checkpoint and Storage Tents

All contractors were generally pleased with the checkpoint. The delivery recipient was perceived as both service-minded and solution-oriented. However, some remarked that the delivery recipient initially lacked material knowledge, which affected the performance negatively. At the same time, people still considered that the delivery recipient was a fast learner.

In the project, the storage tents were both used as intermediate storage and as buffer for certain types of materials, such as plywood and plaster boards. Since having almost dual subcontractors for each profession, several interviewees stated that deliveries at times were mixed between the tents. However, this was perceived to be caused by the suppliers rather than due to disorder on the site. For a while, the TPL-provider tried to keep track of the materials in the tents using an excel sheet. However, since contractors could pick up things whenever, it was difficult to keep it up-to-date. As a result, both TPL2 and TPL3 confirm that they mainly kept in their minds where the materials were placed. The only complaint regarding the storage tents was that the materials were sometimes placed in such a way that made them difficult to access.

As a part of the delivery reception, a quality inspection was performed, mainly by the delivery recipient or a machine operator. The quality of these was questioned by some contractors. However, the more detailed inspection was still the contractors' liability when unpacking the materials. In addition, some subcontractors questioned the management of the delivery notes. These were collected during the delivery reception and was stored in the delivery recipient's office, but sometimes they disappeared along the way. These contractors requested the use of a scanner, or something similar, for delivery notes to be accessed digitally and, thus, easier accessible for project managers and the craftsmen who controlled the deliveries. However, according to TPL2, such a solution requires quite a lot of work to achieve. Instead, to overcome this challenge, SC5 expressed that it rather should be up to each contractor to request digital delivery notes from their suppliers.

4.4.2 Inbound Materials Flow

Most interviewees from the emergency department's project management stated that the inbound materials flow did not work properly. MC6 refers to aspects such as the work environment and efficiency. The former is connected to the increased risks that arise when inexperienced personnel enters a construction site. The latter refers to occasions when too many logistic workers were perceived to perform the same work task. In addition, supervisors felt that they were given extra work since they had to make sure that materials ended up at the right place and that these areas were not occupied with other materials. In other words, extra work which caused frustration when the TPL-arrangement did not turn out as the expectations.

Several project managers from the psychiatry department also mentioned that materials occasionally were misplaced or in the way of assembly. However, these project managers rather perceived that the misplacements occurred due to the human factor, and would still emerge if they managed it by themselves. MC3 also added that when the TPL-provider left the project, more materials were misplaced and deliveries ended up on other projects. However, it might not have been noticed once they were there, but it became apparent when they left. In a similar manner, MC7 mentioned that it may be due to poor communication from their side materials were misplaced, and that is a something they want to improve for next time they use a TPL-arrangement. Moreover, the same interviewee mentioned that their products can be a bit diffused labeled.

The subcontractors had mixed experiences of the inbound materials flow. SC5 did not experience that materials were misplaced except when they made mistakes themselves. SC4 considered that materials sometimes were misplaced, and requested better information from the TPL-provider when it happened to reduce the time used to search for misplaced materials. Furthermore, SC4 and SC2 experienced that the logistics workers sometimes placed deliveries where there was enough space, which could be in the middle of a hallway, making the assembly work more difficult.

Lack of space could also cause one half of a delivery to end up in the correct room, while the other half was placed somewhere else, without being clearly communicated. SC5 has also experienced that some deliveries were placed in one side of a room one day, and on the other side the next day. This complicated the assembly since it sometimes resulted in that various actors' materials and tools were mixed. In addition, SC1 stated that deliveries may have arrived at the incorrect floor and phase, resulting in time losses both in the search for and the transfer of the delivery to its correct position. However, according to SC1, if the purchase planning would have been properly performed, and followed the set restrictions, materials have generally ended up at the right place.

The reason behind misplaced the deliveries was to some extent connected to the human factor. However, according to TPL4, the primary reason for misplaced materials is errors in the planning stage. Often related to that bookings are conducted in the last minute. If making a late delivery call, foremen will have less time to prepare the construction site and the involved personnel. Thereby, information may get lost and labels may not be updated. Thus, time pressure results in that mistakes are made in the preparations. To place packages or pallets according to coordinates of a drawing, TPL4, did not consider to be complicated nor resulted in that many errors. Similarly, TPL2 addressed poor- or miscommunication, from all parties, to be a significant factor causing the issue.

4.5 Visions for Future Applications

All interviewees were positive about using a TPL-arrangement in the future, as long as it is implemented in the right kind of project. What was perceived as the right kind of project varied however between the interviewees. Several actors stated that it needs to be large enough, somewhere in the size of the studied project. Some also pointed out that the project must have the right characteristics. The majority thought that it may be necessary in more urban dense areas or where the surroundings are more sensitive to disturbances. Furthermore, SC2 stated that a high and narrow building may benefit from it, since transport in elevation is more time consuming than lateral movement.

Another aspect that was raised, was the concern that the construction industry increasingly wraps itself up in personnel who possess specific competence, such as construction logistics. The concern was mentioned by one of the psychiatry department's managers. According to this person, there are more and more actors that are supposed to share the same piece of cake. If the construction industry keeps going in the same direction, this manager feared that it eventually will be too expensive to start a construction project. What the interviewee especially perceived as a concern about this trend was that it places an increasing pressure on the decision-makers. Deciding what approach to apply becomes more difficult, not least in smaller projects where the margins are smaller.

For future implementations, TPL3 suggested that one could involve the craftsmen earlier in the project to discuss the TPL-arrangement. MC1 also considered that the solution should have been anchored stronger among the craftsmen. In addition, TPL4 stated that more time maybe should have been spent on anchoring the solution among key persons in the project's early stage. Better communication to enhance the coordination of materials handling in the building is also arisen as a proposal for improvement, mainly among actors within the psychiatry department. SC2 highlighted that all professional groups should spend more time together, coordinating where the different actors' materials should be placed. According to MC7, actors have in this project rather ordered materials to an at the moment empty area. Also, SC1 mentioned that they and other actors could have been more specific in their coordination with others. According to several subcontractors, following up booked deliveries to make sure that they arrive as planned, and keeping the delivery booking system updated with regards to this, could also be improved.

Several of the main contractor's interviewees emphasize the importance for them to continue to be able to control how the production takes place. Interviewees from both project departments therefore express that if possible, they would prefer to handle the logistics by themselves. Thereby, they expect to remain better control of the site, and the personnel allocated to manage the logistics can to a greater extent spend time on other tasks, both in between logistics activities and during the less material-intensive project phases. Furthermore, some actors perceived that the logistics workers lacked experience, which was believed to be linked to the high degree of staff turnover. If possible, they would prefer if the same logistics workers was used to a greater extent. In the future, some contractors also requested that the inbound materials flow would take place earlier during the day, i.e., not after regular working hours. MC2 also mentioned this, mainly to reduce the intensity of the work, but also since MC2 experienced that people still wanted materials to be transferred into the building throughout the day. Thus, several believed that no material movement during the day can be difficult to achieve, not least since deliveries still arrived at any time.

Furthermore, the TPL-provider would have appreciated if less in between storage took place for the materials. The in between storage was only perceived to create extra work and lower the efficiency. However, most contractors appreciated the storage tents, not least due to the difficulties with the material supply due to the Covid-19 pandemic. Moreover, if using storage tents in future applications, MC5 mentioned that it may be more suitable to calculate that materials are moved 1.5 times instead of 1 time when budgeting for the TPL-arrangement. This to make the estimated costs better cohere with how the solution works in reality.

5
Analysis

The following chapter compares literature with empirical findings to analyse the paper's research questions. The chapter is divided into three parts, where each research question is elaborated separately.

- **Section 5.1:** What are the experienced effects of the TPL-arrangement?
- **Section 5.2.3:** How have the project's prerequisites affected the TPL set-up?
- **Section 5.3:** How have the preparations made prior to the implementation affected the outcome of the TPL-arrangement?

5.1 Experienced Effects of TPL-arrangement

In this section, the first research question is analysed. The different logistics segments are discussed separately. First, the delivery restrictions are discussed, followed by the delivery booking system and the delivery reception. Lastly, the effects of the inbound materials flow are discussed.

5.1.1 Delivery Restrictions

According to Ekeskär and Rudberg (2016), contractors may experience regulations regarding booking of deliveries as too fixed. This concern was also identified in the studied case. The contractors did not appreciate that they had to spend time to book all deliveries, especially not the smaller ones. Some also tended to forget to update the bookings when changes occurred. The TPL-provider, on the other hand, attached great importance to the compliance with these regulations to be able to prepare for the reception and handling of deliveries. Thus, there seems to have been a lack of understanding among actors, which will be discussed in more detail in Section 5.3.

However, contractors were not completely against the set booking routines since they saw that the TPL-arrangement facilitated the craftsmen's work. They were mainly opposed to the set detail level. Thus, it does not only seem to be a lack of understanding among contractors, but it may as well have been that the regulations were not sufficiently adapted to the project's setting.

Concerns regarding the labelling were also identified in the studied case. According to the TPL-provider, the label was developed for this specific project together with the main contractor. However, several interviewees stated that suppliers had difficulties to cope with these requirements. Thereby, it may be necessary to involve suppliers when designing the label. Alternatively, one interviewee suggested that the restrictions could concern what information to include on the label, but not what it should look like.

No major concerns have been identified regarding the packaging restrictions. Still, to enable the TPL set-up to reach its full potential, the TPL-provider emphasized the importance to early assess which suppliers may have difficulties to comply with these standards. This to establish proactive solutions for such deliveries. In the studied case, ventilation transports have been identified as deliveries that deviated from the set standards.

5.1.2 The Delivery Booking System

According to Ekeskär and Rudberg (2016), the experience of the IT-system can affect the perception of the TPL-arrangement, both positively and negatively. This is something that also was identified in the studied case. For instance, some interviewees found the delivery planning system as complicated and caused an extra burden, and they were also rather skeptical to the TPL-arrangement. Other interviewees were more positive about the booking system, and had generally a good experience of the TPL set-up.

Most interviewees experienced the IT-system as both easy to learn and apply. It was appreciated that all logistics documents were gathered in the same place, and that the schedule gave an overview of one's own and others deliveries. However, the machine driver found the planning tool as too complex, and containing too much information that was not relevant for this role. In addition, the machine driver would have preferred if the tool could provide notifications shortly before planned deliveries arrived.

Furthermore, some interviewees suggested that the main contractors own IT-system could have been used for the logistics planning in the project. According to (Dubois et al., 2019), a TPL-arrangement requires a joint planning system. However, previous studies did not confirm nor disclaim that the TPL-provider's own IT-system must be used. Yet, the TPL-provider's IT-system collected information about the deliveries, which was used to improve actors' compliance with the set standards. Thereby, to change IT-system could harm the ability for the TPL-provider to fulfill their liabilities, i.e., to reach a more streamlined production.

5.1.3 The Delivery Reception

According to Ekeskär and Rudberg (2016), a driving force to use a checkpoint-based TPL-arrangement is that it brings clarity for how the interface between the off- and on-site logistics activities will be handled. In addition, the introduction of a delivery recipient has been appreciated by all involved actors. Time has been saved, not least for supervisors and foremen since they did not have to cancel their work when deliveries arrived. It was seen as particularly valuable in this project, where there were long distances at the construction site. In addition, the delivery reception reduced the amount of phone calls to the site management. The delivery control is thereby a function many actors advocated to use in the future.

The Storage Tents
Overall, contractors have appreciated the storage tents. However, several contractors expressed that different actors' materials at times were mixed together or were difficult to access in the storage tents. Likewise, interviewees from the TPL-provider found it difficult to establish a functional system to keep order in the tents. It has been difficult to keep it up to date since actors could pick materials from the tents as they pleased. No previous study has addressed how a checkpoint-based TPL-arrangement with tents usually is designed. However, when evaluating the TPL-arrangement, contractors criticized TPL-provider's materials control at the construction site. This indicates that if more projects aim to establish a TPL-arrangement with storage tents, it could be necessary to investigate how to improve the tent structure.

5.1.4 Inbound Materials Flow

The inbound materials flow aroused most criticism from the involved actors. It can mainly be traced to that materials were misplaced or mixed up with other actors' materials. One can recognize from the interviews that this is due to a combination of several factors. Thus, the findings from the interviews propose that a better result could be achieved by:

(1) A better compliance with set booking routines. This to make sure that there is enough time to prepare for the inbound materials flow, such as inform involved personally, and prepare the assembly points.

(2) A better dialogue between actors regarding the coordination in the building. This to avoid getting too much material into the building or that materials are requested to the same location.

(3) That the TPL-provider informs when materials have been misplaced to reduce confusion and time spent on materials search.

(4) Reducing the turnover of logistics workers to make sure that they have a better understanding for the construction site.

The first proposal emphasizes the importance for actors to follow the set requirements. The second proposal suggests that the coordination in the building could be better addressed during logistics and team leader meetings. Furthermore, the third proposal indicates that a proper communication channel that quickly distributed logistics related information was missing. Lastly, the fourth proposal indicates that contractors were not pleased with the personnel turnover among the logistics workers.

5.2 Impact of Project Prerequisites

Compared to earlier studies, the studied project was located in a rural area, and thus, had other project characteristics than commonly dealt with in previous literature (e.g. Dubois et al., 2019). According to (Ekeskär, 2016) the construction setting influences the configuration of the TPL-arrangement. To initiate a standardize way of working can neither be separated from the involved actors (Löwstedt and Sandberg, 2020; Ekeskär, 2016). Consequently, this section will analyse what consequences the construction site's characteristics and the involved actors' experience had on the TPL set-up.

5.2.1 Involved Actors' Experience

Regarding the experience of the TPL-provider, TPL is usually applied in projects with complex environments (Dubois et al., 2019). In accordance, the TPL-provider in the studied project had previously mainly operated in large, complex projects. Especially in city centers or where surrounding businesses put higher demands on well-functioning construction logistics. The logistics manager in the studied project had only experience of projects in the Stockholm region, i.e., of projects where intensive city traffic and lack of space were prevalent.

Regarding the contractors experience, most of them had never been operative in a project of this size or in a project with a complex logistics set-up. Thereby, most contractors lacked practical experience of TPL and had other experiences and perceptions of construction logistics than the TPL-provider. However, this is not surprising since a TPL-arrangement is a relatively new phenomenon in the construction industry (Ekeskär and Rudberg, 2016; Janné and Rudberg, 2022).

5.2.2 Project Characteristics

From a logistics perspective, the characteristics of the studied case was challenging since two material intensive buildings were built in parallel. Thereby, the project included many deliveries that were distributed between many different actors. Consequently, a high level of coordination was required on the site. However, in contrast to previous case studies on TPL-arrangements, the studied case did not lack space, was not located in a city centre, nor in an environment that was sensitive to disturbances. An existing hospital was in direct connection to the construction site. However, these two businesses have not significantly interfered with each other. This is partly because the project had a separate driveways and entrance- and exit gates, and partly since the construction site's had plenty of space. Thus, compared with other hospital projects, the construction traffic has been perceived to run a low risk to disturb the hospital traffic and ambulance routes. Consequently, the setting of the project differed from projects studied in previous literature that applied a TPL set-up.

5.2.3 Application of a TPL-model

It was decided that the TPL-provider's logistics model would be used in the studied project. However, the model was based on the TPL-provider's earlier projects. Thus, since the studied project deviated from the projects the TPL-provider commonly operates within, certain adaptions had to be made. However, according to Sundquist et al. (2018), construction projects are complex and involve many actors, activities and processes that are dependent on each other. Hence, it is not reasonable to expect than one actor alone can develop the best logistics solution for a project. As Karrbom Gustavsson (2018) and Janné and Rudberg (2022) stated, it is thus crucial with a good communication among supply members to succeed with a change such as the application of a TPL-arrangement. However, the addressed differences in backgrounds can hardly have facilitated the communication and cooperation between the involved actors.

5.2.4 Consequences

In summary, the application of the TPL set-up encountered several changes at once. To begin with, a collaboration was established between two parties and their employees, whose experience and perception of construction logistics differed significantly. The TPL set-up was applied in an environment the TPL-provider's employees were not familiar with, together with a logistics model that was not developed in that environment. At the same time, most contractors were not used to the project size, and the personnel intensity it entailed. The logistics solution also implied getting construction workers to adopt a new type of standardized work. Furthermore, previous studies have shown that the involvement of a new actor per se challenges the construction industry's norms, how to collaborate, how activities are carried out, and the division of responsibilities in the project (Karrbom Gustavsson, 2018; Löwstedt and Sandberg, 2020).

In addition, both Ekeskär and Rudberg (2016) and Janné and Rudberg (2022) have in prior studies found that inexperience among actors may cause a reduced compliance with set restrictions. In accordance, contractors in the studied case were found to deviate from putting demands on daily, foreign and urgent deliveries, whereof some admitted that they tended to forget to update changes in the applied booking system. TPL2 also expressed that it was not unusual that contractors expected that they could request the logistics workers' services in the last minute.

However, this does not necessarily mean that the TPL-arrangement was not suitable for a project with the nature of the studied case. The aim with a TPL-arrangement is to reduce the interruptions in production. This by improving the coordination and control of incoming deliveries and on-site logistics activities (Dubois et al., 2019), which was also the most prevalent logistics challenge in the studied case. In addition, it does not neither mean that it would be preferable to handle the logistics in a more traditional manner. In the studied case, contractors have mainly been critical to misplacements of materials. At the same time, when using a traditional way of handling deliveries, there is usually a minimal amount of joint coordination (Dubois et al., 2019). This results in that construction workers spend large parts of their working days searching for and moving materials (Josephson and Saukkoriipi, 2007).

5.3 Impact of Preparations

To answer the third research question, this section is divided into two subsections. First, the objectives with the TPL-arrangement are discussed, followed by an analysis regarding the anchoring of the TPL-arrangement.

5.3.1 Achievement of Set Goals

According to theory, utilization of a TPL-provider decreases the disruptions at the construction site (Janné and Rudberg, 2022; Dubois et al., 2019), which enables contractors to focus on their core business (Maloni and Carter, 2006; Ekeskär and Rudberg, 2016). Thereby, the production pace can be increased (Ekeskär, 2016) and costs cut down (Maloni and Carter, 2006). However, a disappointment linked to time savings could be identified among interviewees, not least within the emergency department's project management. They felt that time had not been saved as they predicted, whereof they had to spend time on solving situations where materials ended up at the wrong place. Nevertheless, other interviewees, such as site managers and supervisors, stated that they have saved time. For instance, since they hardly received any phone calls from drivers.

Hence, there are different opinions whether the TPL-arrangement has been beneficial or not. Since no follow-ups have been conducted, neither in terms of time or money, it is hard to tell whether time have been saved by using the TPL-arrangement in the project. However, the raised concerns should not be neglected, but rather embraced since they according to Ford and Ford (2010) can improve the TPL-arrangement to better fit the production.

The importance of tangible targets

Based on the preliminary budget, it was estimated that a 7% increase in production efficiency would make up for TPL-arrangement's cost. Since Josephson and Saukkoriipi (2007) identified that 15% of craftsmen's time is spent on materials handling when using a traditional approach, 7% can be considered as a reasonable target since the intention was that craftsmen would not spend time on materials handling. Nevertheless, it can be questioned how measurable, and thus, useful such a target is. Interviewees from both project management teams considered it to be difficult to measure, and thus to prove whether predicted time savings were achieved or not.

Similar to aligning the viewpoints of the management and craftsmen, as stated by Löwstedt and Sandberg (2020), it may also be necessary to align the ultimate goals with tangible goals in the production. Goals which better comply to the daily activities which easily can be monitored to better control the logistics performance. For instance, it would be possible to calculate unit times for craftsmen and compare these numbers with unit times from earlier projects. However, it will require effort to gather such numbers meaning that time saved in e.g. mounting, might instead be used for data gathering, risking that in total, no time is saved. In addition, the unit times could also be affected by other circumstances, such as the craftmen's competence and the characteristics of the assembly point.

Utilization of JIT

In the project, deliveries have generally arrived before lunch, but the inbound materials flow did not take place until the afternoon. Materials have also been stored in the tents for longer periods. Hence, a JIT-approach have not been used in this project. It can be discussed whether a JIT-approach should have been applied in the project for a successful implementation. According to Dubois et al. (2019), JIT is commonly used together with TPL-arrangements to improve the on-site efficiency. Thereby, that JIT has not been used may have affected the outcome of the TPL-arrangement. However, since the Covid-19 pandemic made it difficult to get access to materials, it was in this project to some degree necessary to store materials. Commonly, lack of space is something that advocates the use of JIT. However, the studied project did not have lack of space. Thereby, it was hard for the TPL-provider to persuade the contractors to adopt this approach. If JIT is not used, you need to budget for an increased number of material movements. For instance, MC5 proposed 1.5 movements instead of 1, which was budgeted for in this project.

From an environmental perspective, it is also preferable to reduce the material storage at the site. This since storing often leads to that materials get lost or damaged (Dubois et al., 2019), which according to interviewees also was prevalent in the studied case. To get a more streamlined production, the TPL-provider advocated JIT-deliveries. Use of JIT-deliveries may also decrease the intense work load for the machine drivers. In the project, there were some intense hours before the logistics workers arrived when all materials were moved from the storage tents to the unloading zones by the buildings. By using JIT, these materials movements would be more evenly spread out during the day, which thereby could entail a better work environment for the machine drivers.

5.3.2 Anchoring the TPL-arrangement

For a successful implementation of TPL, Ekeskär and Rudberg (2016) emphasized the importance of initiating the arrangement in the project's early planning to set realistic budgets and time frames. Accordingly, the TPL-arrangement was in the studied case introduced almost a year before the application. Thereby, the TPL-arrangement was accounted for, both in the project's budget and the time frame.

Furthermore, Ekeskär (2016) and Janné and Rudberg (2022) have found that it is common that doubt arise among construction workers when implementing TPL-arrangements. Likewise, most interviewees expressed that they initially were a bit doubtful regarding the TPL-arrangement, even though it seemed promising. According to Ekeskär and Rudberg (2016), early skepticism may be connected to mistrust. In the studied project, some actors doubted the TPL-provider's ability to make the TPL-arrangement work in practice, at least without interfering with how they want to perform their construction activities.

Consequently, several actors expressed that it was a decisive moment when deliveries started to arrive to the site. It was not until then, when actors saw that it actually worked in practice that they started to believe that the solution could be profitable. At the same time, according to interviewees from the psychiatry department, the TPL-arrangement initially required both time and effort to be adjusted to the project's setting. Thus, it is not plausible to expect that the solution will work flawless from start. Instead, as Löwstedt and Sandberg (2020) emphasized, the application of a standardized manner to handle logistics must regard the involved people. Furthermore, according to Karrbom Gustavsson (2018), TPL-providers may get caught in the middle of being or not being considered as a part of a project team. Thus, to early involve the TPL-provider can be beneficial to enhance the team spirit among project participants.

Consequently, the TPL-arrangement seems to require an early implementation in the production to acclimatize to the construction project. In addition, more managerial attention may initially be required to ensure that the solution is steered in the right direction and not gets caught in a vicious circle. That means, in a circle where actors are reluctant and deviates from the set restrictions, which negatively affects the TPL-arrangement. In turn, this increases the reluctance, which impairs the arrangement even more. In accordance, the main contractor's project management decided to early involve the TPL-provider at the site to give them a chance to get to know the project's setting and the involved actors before the most intense production period started. However, there were different opinions whether the TPL-provider entered the construction site at a suitable time. TPL3 suggested that they perhaps should have entered the construction site even sooner to have more time to establish relationships. Thereby, a better trust among craftsmen was believed to be gained, who were identified by TPL3 as most challenging to get on board.

Interviewees from the main contractor on the other hand, consider that they gave the TPL-provider plenty of time to get to know the project's setting and the involved actors before the most intense production period started. Some interviewees even claimed that the TPL-provider entered the project too early, causing people to question what the logistics manager actually did. According to them, friction arose in the project's early stage due to this. In addition, they were not impressed by the TPL-provider's design of the site layout for the logistics functions.

However, the project managers from the emergency department experienced that the solution worked worse over time. This pattern may indicate that the TPL-arrangement got stuck in a vicious circle, and thus, that the acclimatization to the emergency department could have been more successful. That they felt that the TPL-arrangement was implemented too early could be due to lack of communication, since it was the main contractor's project management who decided that the TPL-provider should be involved early.

Based on empirical findings and theory, it can thus be seen that the solution should be implemented earlier than the critical phase for logistics, but it is difficult to determine exactly when. Too early will per se have a breaking point when it is not financially defensible, but it may also encounter other challenges, such as the previously identified challenges for the emergency department. However, there is no point in trying to determine what the perfect time would be for the implementation in the studied project. The perfect time in next project will anyway depend on the involved actors and the project's characteristics. However, the identified issues in the emergency department leads to the suggestion that the planning phase in future projects should include more communication about the importance of the early phase. For instance, when to apply the arrangement and required extra resources in the early stage, such as managerial attention, extra meetings between craftsmen and logistics manager etc. This, to establish an increased awareness of why an early implementation is important, and to ensure that the TPL set-up has the conditions to get a good start and become independent over time.

Anchoring an Understanding

The initiator of the TPL-arrangement had earlier experience of procuring a TPL-provider. Thus, this person possessed prior knowledge in how to prepare logistics documents and agreements. Knowledge exchange between projects is something Karrbom Gustavsson (2018) expressed as beneficial when adopting a TPL-arrangement. This since it enables lessons learned in practice to be transferred between projects. In the studied case, benefits gained from this can also be identified. For instance, it can be seen in that TPL4 stated that the main contractor's intentions with the arrangement were clear. Moreover, it is likely one of the main reasons why several actors expressed that they felt well-informed about the logistics set-up before the application and that the produced documents were perceived as helpful when expressing the set requirements for suppliers.

According to Dubois et al. (2019), to gain any effect with a TPL-arrangement, it is important to follow a more standardized approach to handle construction logistics, and thereby the use of a joint information system. The TPL-provider described that it was important for them that people used the system so they could plan the workforce and other required resources for their operations. This is something also Ekeskär and Rudberg (2016) emphasized, that unexpected deliveries could severely affect the performance of the TPL-arrangement. According to Dubois et al. (2019), to reach the full potential of a TPL-arrangement, it is required to book several days in advance and to keep the logistics manager informed of changes. Still, involved actors stated that they did not always book their deliveries. This resulted in unexpected deliveries, which may be one reason why the TPL-arrangement did not work out as intended.

Whether the importance of the bookings have reached the participants in the project is hard to tell. Actors have commonly not put in effort to book all deliveries, but they have still raised complaints when the logistics workers did not have time to move their materials to the assembly points. Thereby, it seems like many actors did not see the connection between the booking of deliveries and the inbound materials flow. Hence, involved actors might not have understood why it was important for them to book all deliveries. Lack of understanding is something Janné and Rudberg (2022) discovered could harm the success of a TPL-arrangement. Similar to the studied case, Janné and Rudberg (2022) found that several actors deviated from the set regulations. Therefore, for next project, the TPL-provider and the main contractor's project management should early in the project state why it is important that set regulations are followed and what consequences it might bring if these are not followed.

6
Conclusion

This master's thesis began by declaring why researchers claim construction logistics to be a topic in need of further attention, and how it has led to a grown interest for TPL. Furthermore, the empirical case revealed that construction projects in rural areas also call for better construction logistics. However, the TPL-arrangement is still a relatively new concept for actors within the construction sector and have yet mainly been adopted in urban areas. Likewise, previous studies mainly concerned complex projects in urban areas with lack of space for storage or where the surroundings were sensitive for disturbances.

Three research questions were constructed to contribute to TPL research and to improve the outcome of TPL-arrangements. This in rural areas with other characteristics than in urban areas. Chapter 5 analyzed these questions based on the empirical and literature findings, whereof this chapter will provide a more concise answer to each question. Thereafter, it is discussed how future TPL-arrangements can be improved, followed by the master's thesis research contribution. Lastly, the limitations of the study and proposals for future research are presented.

6.1 Answering Research Questions

What are the experienced effects of the TPL-arrangement?

Generally, the involved actors have appreciated the delivery reception, since it decreased the number of disruptions for both construction workers and managers. Also, the storage tents have been appreciated since these facilitated the construction during a time period when it was difficult to access materials. However, the TPL-provider did not appreciate the extent to which the storage tents were used since it counteracted the use of JIT-deliveries.

The applied IT-system received various reviews. Some appreciated the system since it provided an overview of their own and others deliveries, whereas others thought that the system was difficult to use in production or was considered to cause an extra burden. However, most complaints could be traced to a dissatisfaction regarding the delivery restrictions. They were perceived as too fixed, since all deliveries had to be booked 5 days in advance, and that the label had to look in a certain way. It was difficult to make suppliers fulfil these demands.

The materials handling was appreciated once it worked. Especially subcontractors perceived the inbound materials flow to lower their workload. However, many actors stated that materials tended to get misplaced, resulting in that time had to be spent on solving these errors. Thereby, this part of the TPL-arrangement aroused the most criticism from contractors.

How have the project's prerequisites affected the TPL set-up?

The implementation did not only require adjustments to the specific project, but the TPL-model had to be adapted to a context for which it had not yet been used. Furthermore, the TPL-provider was unfamiliar with the project's characteristics and most contractors had limited experience of TPL. This led to different perceptions regarding how construction logistics should be performed, and thus, made it more difficult for both parties to understand and cooperate with each other.

Hence, the implementation encountered several novelties at once, which due to the well-addressed issue of resistance to change made the design and application of a TPL set-up more challenging. However, this insight does neither confirm or deny that the TPL-arrangement was not suitable for this type of project, nor that a traditional logistics approach would have been more appropriate. Yet, it is one reason why the TPL-arrangement had difficulties to reach its full potential.

How have the preparations made prior to the implementation affected the outcome of the TPL-arrangement?

The preparations made prior to the implementation have followed the recommendations from literature. The TPL-arrangement was early initiated, and was thereby accounted for both in the budget and the time plan. To let a person with earlier experience of TPL be in charge of the implementation has influenced the application positively, since it set a good foundation for the set-up.

The set targets in the project were somehow intangible and no proper follow-ups were conducted, thus, the main contractor cannot state whether the set objectives were achieved or not. Thereby, in forthcoming TPL applications, it is suggested to set more tangible, measurable targets which can be monitored in the daily production.

Various actors expressed that they were well-informed about the TPL-arrangement prior to use. However, most actors did not seem to understand why it was necessary to book all deliveries. Accordingly, many actors deviated from the set restrictions. According to theory, understanding enhances the compliance with set requirements. Scepticism towards the TPL-arrangement has also been identified, both in the project's early phase and during production, especially among craftsmen. Scepticism is connected to lack of understanding. Thereby, it is suggested to better anchor the arrangement for next application to increase the understanding for the set requirements and the awareness of why, when and how an implementation should be realized. Altogether, an increased understanding will improve the compliance with restriction and, thus, the outcome of the TPL-arrangement.

6.2 Discussion and Proposals

In this section, aspects that need to be taken into consideration when applying TPL-arrangements are raised. The proposals are based on research's findings, and the authors' own reflections.
Make sure that the TPL-arrangement is early applied, it will give the arrangement time to accumulate to the project's setting. Furthermore, scepticism and lack of understanding was found to affect the TPL-arrangement negatively since it resulted in deviations from the set restrictions. Therefore, make sure that all involved actors understand why the TPL-arrangement is applied, why it is implemented at the specific time, and why delivery requirements are set.

To prevent the project from getting caught in a viscous circle where actors are reluctant and deviates from set requirements, extra managerial attention may initially be required. For instance, it may be necessary to have meetings with craftsmen to anchor the arrangement and thereby prevent resistance. Also, to invite suppliers and distributors to the construction site has proven to be successful. It is advantageous to involve them early to ensure that the set demands can be met This to proactively deal with deliveries that cannot meet the set standards.

Issues regarding the delivery label have also been identified in the project. Thus, regarding its design restrictions, it could be preferable to only require what information that needs be attached on the deliveries, while the label can be designed as it suits. For instance, the information that does not fit on the label could instead be included on a separate paper.

In addition, having access to a schedule that gives an overview of all upcoming deliveries was appreciated among project managers. It prevented deliveries from arriving at the same time. Thus, to use a joint delivery booking calendar could be useful in all types of projects. Furthermore, a TPL-provider will need means to reach the outcome they are hired for. Therefore, it may be appropriate to use their delivery booking system since functions within the system may be used as control means.

If the project setting allows JIT-deliveries, it is preferable to use to streamline the production. However, due to uncertainties regarding leading times for certain types of deliveries and limited access to some materials, it can be difficult to fully use a JIT-approach. Still, large amounts of material storage will result in double-handling and material damage. Thus, when using a TPL set-up with storage tents, it could be advantageous to set clearer restrictions in the early planning, i.e., regarding what materials to store and what deliveries that will adopt a JIT-approach.

Lastly, the provided suggestions cannot be taken for granted as generic. Consideration must be taken to the nature of the specific project before application. For instance, to use a delivery reception, will not guarantee a successful outcome. The success of the delivery reception in the studied case was probably linked to the long distances at the site, the intense amount of deliveries and the delivery recipient's personality and capacity.

6.3 Research Contribution

This master's thesis has shed light on a lack of research that captures TPL in a broader spectrum of construction projects. By studying a project located in a rural area, this thesis contributed to fill this gap. Firstly, by studying the challenges that can arise when transferring a logistics solution that was developed for urban areas into this context. Secondly, by capturing TPL's development in the construction industry by identifying the encountered benefits and drawbacks in a recent use of TPL. This by taking several involved actors' experience into consideration. Thirdly, this master's thesis has contributed to practical-oriented TPL research by discussing what contractors in the construction industry should pay further attention to when preparing for an application of TPL.

6.4 Limitations & Future Research

As the majority of studies, the findings of this master's thesis are subject to limitations. This study was based on a single-case study in Sweden and primarily used Swedish literature. Thus, the application of the findings may lead to unforeseen consequences in other regions and countries. The results of a single-case study cannot and were neither intended to be transferable to all types of project contexts. However, the clear description of the case and the TPL-arrangement made the findings transferable for projects and contractors operative in similar contexts. Nevertheless, a single-case study should not be considered to fairly represent the reality for the entire construction industry. Thus, the thesis' findings should rather be interpreted as possible effects of a TPL-arrangement.

The study addressed an on-going construction project, which strengthens the relevance of the empirical findings. Furthermore, the amount of interviews enabled several perspectives to be taken into consideration. The identified issues in the study are also linked to suppliers and distributors. However, due to the limitation of time, suppliers and distributors were not within the scope of the study. Thereby, the findings primarily represent the downstream supply chain and contractors' point of view.

Throughout the study, it was challenging to find reference projects to compare with the empirical findings. Previous research primarily concerned contexts such as urban areas, sensitive environments or construction sites with a lack of space for storage. None of these correspond to the characteristics of the empirical case. Hence, the limited access to comparable studies may have influenced the quality of the research's analysis. Consequently, there is a need for further research that compiles a larger sample of case studies on TPL-arrangements in such context.

Moreover, several topics have been identified that requires further research. For instance: When is outsourcing of logistics functions suitable in construction?; How should storage tents be organized to better keep track of what they contain?; Can the mix of TPL and storage tents be used to direct more projects towards adopting a logistics approach closer to JIT? The latter refers to that the storage tents overcome some of the uncertainties that decrease the willingness to apply JIT, such as enable a buffer when materials are difficult to access.

Furthermore, a gap was noted regarding how the logistics objectives should be transformed into measurable targets in the production phase. Objectives that enable continuous monitoring could for instance serve as control means to encourage the compliance with set restrictions. It could also be used to more clearly visualize the gains and where the arrangement can be improved in terms of costs, productivity, and material waste. Thus, the empirical findings indicate a need for future research to find more feasible ways to monitor the logistics performance in a project's daily operations.

Bibliography

Agapiou, A., Clausen, L., Flanagan, R., Norman, G., and Notman, D. (1998). The role of logistics in the materials flow control process. *Construction Management & Economics*, 16(2):131–137. https://doi.org/10.1080/014461998372420.

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

Allabolag (n.d). Available online at: https://www.allabolag.se/, accessed 2022-04-14.

Bell, E., Bryman, A., and Harley, B. (2019). *Business research methods*. Oxford University Press, 5th edition.

Bertin, I., Saadé, M., Le Roy, R., Jaeger, J.-M., and Feraille, A. (2022). Environmental impacts of design for reuse practices in the building sector. *Journal of Cleaner Production*, 349:131–228. https://doi.org/10.1016/j.jclepro.2022.131228.

Christopher, M. (1992). *Logistics & supply chain management*. Pearson Uk.

Dubois, A. and Gadde, L.-E. (2002). Systematic combining: an abductive approach to case research. *Journal of business research*, 55(7):553–560. https://doi.org/10.1016/S0148-2963(00)00195-8.

Dubois, A., Hulthén, K., and Sundquist, V. (2019). Organising logistics and transport activities in construction. *The International Journal of Logistics Management*, 30(2):620–640. https://doi.org/10.1108/IJLM-12-2017-0325.

Easterby-Smith, M., Thorpe, R., and Jackson, P. (2015). *Management & Business Research*. Sage.

Ekeskär, A. (2016). *Exploring Third-Party Logistics and Partnering in Construction: A Supply Chain Management Perspective*. PhD thesis, Linköping University Electronic Press.

Ekeskär, A. and Rudberg, M. (2016). Third-party logistics in construction: the case of a large hospital project. *Construction Management and Economics*, 34(3):174–191. https://doi.org/10.1080/01446193.2016.1186809.

Ford, J. D. and Ford, L. W. (2010). Stop blaming resistance to change and start using it. *Organizational Dynamics*, 39(1):24–36. https://doi.org/10.1016/j.orgdyn.2009.10.002.

Fulford, R. and Standing, C. (2014). Construction industry productivity and the potential for collaborative practice. *International Journal of Project Management*, 32(2):315–326. https://doi.org/10.1016/j.ijproman.2013.05.007.

Guerlain, C., Renault, S., and Ferrero, F. (2019). Understanding construction logistics in urban areas and lowering its environmental impact: A focus on construction consolidation centres. *Sustainability*, 11(21):6118. https://doi.org/10.3390/su11216118.

Hsieh, H.-F. and Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, 15(9):1277–1288. https://doi.org/10.1177/1049732305276687.

IEA (2021). 2021 global status report for buildings and construction. *United Nations Environment Programme.*

Janné, M. and Rudberg, M. (2022). Effects of employing third-party logistics arrangements in construction projects. *Production Planning & Control*, 33(1):71–83. https://doi.org/10.1080/09537287.2020.1821925.

Josephson, P.-E. and Saukkoriipi, L. (2007). Waste in construction projects: Call for a new approach. Technical report, Chalmers University of Technology.

Karrbom Gustavsson, T. (2018). Liminal roles in construction project practice: exploring change through the roles of partnering manager, building logistic specialist and bim coordinator. *Construction Management and Economics*, 36(11):599–610. https://doi.org/10.1080/01446193.2018.1464197.

Lambert, D. M. and Cooper, M. C. (2000). Issues in supply chain management. *Industrial Marketing Management*, 29(1):65–83. https://doi.org/10.1016/S0019-8501(99)00113-3.

Lindén, S. and Josephson, P.-E. (2013). In-housing or out-sourcing on-site materials handling in housing? *Journal of Engineering, Design and Technology*, 11(1):90–106. https://doi.org/10.1108/17260531311309152.

Löwstedt, M. and Sandberg, R. (2020). Standardizing the free and independent professional: The case of construction site managers in sweden. *Engineering, Construction and Architectural management*, 27(6):1337–1355. https://doi.org/10.1108/ECAM-11-2018-0489.

Maloni, M. J. and Carter, C. R. (2006). Opportunities for research in third-party logistics. *Transportation Journal*, 45(2):23–38. https://doi.org/10.5325/transportationj.45.2.0023.

Muerza, V. and Guerlain, C. (2021). Sustainable construction logistics in urban areas: A framework for assessing the suitability of the implementation of construction consolidation centres. *Sustainability*, 13(13):7349. https://doi.org/10.3390/su13137349.

Osmani, M. (2011). Chapter 15 - construction waste. In Letcher, T. M. and Vallero, D. A., editors, *Waste*, pages 207–218. Academic Press, Boston. https://doi.org/10.1016/B978-0-12-381475-3.10015-4.

Premkumar, P., Gopinath, S., and Mateen, A. (2021). Trends in third party logistics–the past, the present & the future. *International Journal of Logistics Research and Applications*, 24(6):551–580. https://doi.org/10.1080/13675567.2020.1782863.

Selviaridis, K. and Spring, M. (2007). Third party logistics: a literature review and research agenda. *The International Journal of Logistics Management*. https://doi.org/10.1108/09574090710748207.

Sezer, A. A. and Fredriksson, A. (2020). The transport footprint of swedish construction sites. In *IOP Conference Series: Earth and Environmental Science*, volume 588. IOP Publishing. https://doi.org/10.1088/1755-1315/588/4/042001.

Sezer, A. A. and Fredriksson, A. (2021). Paving the path towards efficient construction logistics by revealing the current practice and issues. *Logistics*, 5(3):53. https://doi.org/10.3390/logistics5030053.

Sullivan, G., Barthorpe, S., and Robbins, S. (2011). *Managing construction logistics*. John Wiley & Sons.

Sundquist, V., Gadde, L.-E., and Hulthén, K. (2018). Reorganizing construction logistics for improved performance. *Construction Management and Economics*, 36(1):49–65. https://doi.org/10.1080/01446193.2017.1356931.

Swamidass, P. M., editor (2000). *Seven "rights" of logistics*, pages 684–684. Springer US, Boston, MA. https://doi.org/10.1007/1-4020-0612-8_871.

Thunberg, M. (2013). *Towards a framework for process mapping and performance measurement in construction supply chains*. PhD thesis, Linköping University Electronic Press.

Thunberg, M. and Persson, F. (2014). Using the scor model's performance measurements to improve construction logistics. *Production Planning & Control*, 25(13-14):1065–1078. https://doi.org/10.1080/09537287.2013.808836.

Vrijhoef, R. and Koskela, L. (2000). The four roles of supply chain management in construction. *European Journal of Purchasing & Supply Management*, 6(3):169–178. https://doi.org/10.1016/S0969-7012(00)00013-7.

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