CHALMERS
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Outsourcing Construction Logistics

Organising construction deliveries using Third-Party Logistics

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

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Department of Architecture and Civil Engineering
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CHALMERS UNIVERSITY OF TECHNOLOGY
Master's Thesis ACEX30-19-82
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ABSTRACT

The construction industry, as of today, accounts for 13% of the global GDP, which translates to approximately $10 trillion. This number is expected to reach $17,5 trillion by the year 2030. At the same time, with low levels of productivity being a recurring theme, the construction industry is somewhat infamous for its inefficiency. When speaking of productivity, the construction industry is occasionally compared to the manufacturing industry, and the difference in levels of productivity. The manufacturing industry does display greater productivity levels, but the construction industry also naturally has a major disadvantage. While manufacturing companies can pick strategic locations for their facilities to help ensure efficient logistics, the construction industry is peripatetic, forcing the contractor to adapt to the project location and surroundings, as well as the challenges it brings. However, with this disadvantage in mind, logistics in the construction industry also rarely gets the attention that it demands. It is somewhat taken for granted.

In recent years, hiring Third-Party Logistics companies, has become a rising trend within the construction industry. Third-Party Logistics companies, also referred to as TPL, are essentially firms that have logistics as their area of expertise, and there are those that have specialised towards the construction industry. With the TPL provider responsible for organising and managing the incoming deliveries, the contractor has the opportunity to put greater focus on the construction process itself. Additionally, it is possible to hire TPL companies for on-site handling of the incoming materials, allowing the contractor's workers to produce, rather than having to spend large quantities of time on handling materials.

In this thesis, a survey based on strategic, financial and operational driving forces and concerns related to TPL implementation in the construction industry, has been implemented. The driving forces and concerns has been identified in previous literature on the topic. People in the construction industry, with experience of hiring TPL companies, have been asked to fill out the survey, and the responses have been compiled to enable comparison between the different forms of TPL implementation. In total, 40 responses have been taken into account, indicating that each form of implementation has its strengths and weaknesses respectively.

Keywords: construction logistics, third-party logistics, lean production, lean construction, just-in-time, last planner, supply chain, construction consolidation centre, delivery booking system

Utläggning av bygglogistik
Organisering av leveranser i byggbranschen genom anlitande av tredjepartslogistiker
Examensarbete inom masterprogrammet Organisering och ledning i bygg- och fastighetssektorn
ROBERT HEDLUND
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Institutionen för Arkitektur och Samhällsbyggnadsteknik
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SAMMANFATTNING

Byggindustrin står i dagsläget för 13% av världen BNP, vilket motsvarar ungefär $10 miljarder. Den siffran förväntas stiga till $17,5 miljarder år 2030. Samtidigt, med låg produktivitet som ett återkommande ämne, är byggbranschen något ökänd för dess ineffektivitet. När man talar om produktivitet jämförs byggindustrin med tillverkningsindustrin, och skillnaden i produktivitet. Tillverkningsindustrin uppvisar förvisso högre produktivitetsnivåer, men har också en naturlig fördel gentemot byggindustrin. Medan företag inom tillverkningsindustrin har möjligheten att välja strategiska positioner för sina anläggningar, vilket banar väg för god logistik, är byggindustrin ambulerande, vilket tvingar byggföretagen att anpassa sig till projektet plats och omgivningar, samt de utmaningar det medför. Vidare, med denna nackdel i åtanke, får logistiken sällan heller det fokus som krävs inom byggindustrin. Det tas lite för givet.

På senare år har det blivit en ökande trend att anlita tredjepartslogistiker inom byggbranschen. Tredjepartslogistiker, även kallade TPL, är företag som har logistik som sin kärnkompetens, och det finns även de som specialiserat sig på byggindustrin. Med TPL som ansvarig för att organisera och ombesörja inkommande leveranser, kan byggföretaget lägga mer fokus på själva byggprocessen. Det är även möjligt att anlita TPL för inbärning av levererat material, vilket ger yrkesarbetarna möjlighet att producera, då de inte behöver lägga en stor del tid på att bära in material.

I detta arbete har en enkät tagits fram, baserad på strategiska, finansiella och operativa drivkrafter och svårigheter relaterade till implementering av TPL inom byggindustrin. Dessa drivkrafter och svårigheter har identifierats i tidigare litteratur på området. Personer, verksamma i byggbranschen och med erfarenhet av att anlita TPL-företag, har blivit ombedda att fylla i enkäten. Svaren har sedan sammanställts för att möjliggöra en jämförelse mellan de olika implementeringstyperna för TPL. Totalt 40 svar har beaktats, och tillsammans indikerar de att varje implementeringstyp har sina för- respektive nackdelar.

Nyckelord: bygglogistik, tredjepartslogistik, lean production, lean construction, just-in-time, last planner, supply chain, samlastningscentral, tidsbokningssystem

Contents

Preface

So, this is it. This thesis marks the end of our Master of Science studies at the Design and Construction Project Management programme at Chalmers University of Technology. It has been conducted at the Department of Architecture and Civil Engineering over the course of five months, ranging from January through June of 2019.

Several people have been of great help in accomplishing this thesis. First and foremost, we would like to thank our supervisor Abderisak Adam for his great support and availability throughout the process of the thesis. Much obliged. We would also like to thank Company A for taking the time to meet us. Last but not least, an immense thanks to all the people who has contributed to making this thesis possible.

It has been really interesting to look into the topic of construction logistics, and it has brought us great knowledge along the way. Without further ado, we now look forward to getting rid of our substantial collection of browser tabs.

Thanks!

Robert Hedlund and Gerardo Telese
Gothenburg, June 2019

Abbreviations

CCC	Construction Consolidation Centre
CLP	Construction Logistics Plan
DBS	Delivery Booking System
JIT	Just-in-Time
LC	Lean Construction
LP	Lean Production
LPS	Last Planner System
OSH	On-Site Handling
SCM	Supply Chain Management
TPL	Third-Party Logistics

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1 Introduction

The importance of the construction industry stretches far beyond its mere economic value, since it provides us with the environment in which we live, work and produce. The economic magnitude of this sector is substantial, considering that, today, 7% of the world's working population is employed in this sector, and that it is responsible for 13% of the world GDP for an estimated total of $10 trillion (McKinsey Global Institute, 2017). In Sweden, this corresponds to approximately 6% of the working population working in the construction industry in 2016, based on figures retrieved from Sveriges Byggindustrier (2017) and Trading Economics (2019), and 14.5% of the Swedish GDP, based on figures retrieved from Sveriges Byggindustrier (2017) and Statistiska Centralbyrån (2018). Furthermore, according to Global Construction Perspectives and Oxford Economics (2015) the global figures are expected to increase and reach $17,5 trillion by the year 2030, 14.7% of the global GDP.

One of the recurring themes in the construction industry is its low levels of productivity (McKinsey Global Institute, 2017; Josephson & Saukkoriipi, 2005). McKinsey Global Institute (2017) state that in the last 20 years, productivity in the construction has been growing at an annual rate of just 1%, falling behind the average productivity growth of the world economy (2.8%) and the productivity growth rate of the manufacturing industry (3.6%). In Sweden, even if the industry show productivity levels that are above average in construction, the level of productivity growth is relatively low compared to the manufacturing industry, indicating a low level of innovation and moving the country industry close to the "declining leaders" (McKinsey Global Institute, 2017).

What can the construction industry do in order to breach this gap? According to McKinsey Global Institute (2017), the construction sector can learn from the manufacturing industry and its practices, with a potential for productivity increase that, depending on the process, can reach up to 10x improvement. In this sense, considering its vast presence in the literature, one of the most common trends in the construction industry, to try to improve productivity, has been the adaptation of the Lean manufacturing process to the building sector, also called *Lean Construction* (LC), which has shown promising results (Bertelsen & Koskela, 2004; Gao & Low, 2014). One of the main aims of LC is to reduce construction waste, in terms of time, cost and quality, by focusing on the whole supply chain, ensuring a smooth and efficient workflow (Josephson & Saukkoriipi, 2005). *Supply Chain Management* (SCM), *Just-in-Time* (JIT) and *Last Planner System* (LPS) are just few of the many LC tools that can be implemented (Gao & Low, 2014; Seppänen & Peltokorpi, 2016). Rushton, et al., (2014) mentions that, due to the number of fixed assets in logistics operations, e.g. warehouses, depots and equipment for handling material, there could be good opportunities to outsource such operations. Additionally, Ekeskär (2016) explains that, in recent years, some construction companies have begun to hire Third-Party Logistics companies (TPL). Their aim is to facilitate a smooth delivery system and an uninterrupted workflow and ensure that construction workers can focus uniquely on the building process. LC tools, such as SCM and LPS, can be applied to the everyday practices of TPL companies. Thus, said tools are described and their implementation in the construction industry are analysed.

The role, tasks and relations between TPL companies and the construction companies can vary depending on the project. However, Ekeskär (2016) lists those that, in the literature, have emerged as common factors that can stimulate or hinder the implementation. Nonetheless, Ekeskär (2016) highlights a lack in empirical research on the real-life benefits of hiring TPL companies. For this reason, this work tries to breach this gap, seeking to empirically identify the benefits and the disadvantages of hiring a TPL company, according to the direct experience of the TPL companies' clients.

1.1 Aim and research question

The purpose of this study is to identify and examine different types of implementation of Third-Party Logistics companies towards the construction industry, their practices and how they can affect the construction supply chain. Direct experiences from such implementation are compared in order to identify benefits and shortcomings. Eventually this leads to concrete suggestions, based on the literature and observations, for an efficient implementation of TPL in the construction industry. Thus, the following research question are addressed:

- Which are the main forms of TPL implementation in the construction industry today?
- What are the strengths and weaknesses with each form of TPL implementation, as experienced by the clients?
- How can TPL be implemented in the most effective and beneficial way, and how can the identified weaknesses be overcome?

1.2 Case Description

In order to get an insight on a TPL company and their point of view on the construction industry, Company A is considered. Company A is a third-party logistics company with several years of experience within construction logistics in Northern Europe, where they have been involved in a raft of construction projects, ranging from apartments and hotels to shopping malls and hospitals. Furthermore, this thesis focuses on the reception of deliveries to the construction site and seek room for improvement, based on the experiences of TPL customers across the construction industry.

1.3 Delimitations

This work primarily considers construction logistics as the management of the whole supply chain, and the inflow of materials to the construction site. However, in order to guarantee a smooth inflow of materials, a well-planned construction site is fundamental. For this reason, on-site logistics are also be considered, since it is a necessary condition for a good delivery system. As a further delimitation, this study is conducted entirely in Sweden and for this reason it only addresses the Swedish construction sector. Consequently, the results and the conclusion of this research are mainly applicable to the Swedish construction industry.

1.4 Thesis outline

The thesis is divided into six chapters, as follows:

Chapter 1 – 'Introduction' is meant to introduce the reader to the subject and give an understanding of the importance of construction logistics. Upon this, the aim of the thesis is also presented.

Chapter 2 – 'Theoretical framework' is based on literature and previous research and aims to give the reader sufficient information on the topic. The framework also forms the foundation for the analysis, together with the empirical findings.

Chapter 3 – 'Method' describes the approaches that have been used to establish the theoretical framework and gather empirical material. Additionally, this chapter contains a part about the ethical research, as well as the trustworthiness of the thesis.

Chapter 4 – 'Empirical findings' presents the results that have been achieved through empirical studies.

Chapter 5 – 'Analysis and Discussion' holds the analysis of the empirical findings. The findings are compared using the theoretical framework, and tie back to the research questions presented in the first chapter. Upon analysis, the results are also discussed.

Chapter 6 – 'Conclusion' aims to answer the research question by presenting conclusions of the study. Finally, this chapter hold a few suggestions for future research.

2 Theoretical framework

This chapter covers the literary findings regarding construction logistics. Central concepts regarding construction logistics, such as supply chain, TPL and lean construction, are defined, in order to provide a theoretical framework that consequently is used to analyse and comment the empirical research.

The exact definition of logistics tend to vary between authors, but the main conception is that it is "the movement and storage of goods, together with the associated information flows, from the beginning to the end of the supply chain" (Browne, 2015, p. 10), with the supply chain ranging from the point of manufacturing to the point where the product gets either recycled or discarded (Browne, 2015). This is logistics in general. Logistics in the construction industry is different.

2.1 Construction logistics and its relevance

Construction projects come in all sizes, from private houses being built to entire districts taking place, with lots of activities occurring in the same place concurrently (Robbins, 2015). Since construction projects also run for a limited period of time with conditions changing continuously throughout the project, the construction industry is lacking the continuity of many other industries (Lundesjö, 2015). By the same token, the construction industry is peripatetic, meaning that while a factory can settle down in a location and get familiar with their prerequisites, construction sites must move to where the work is (Shakantu, et al., 2008).

Historically, construction companies have typically carried out the majority of the work themselves without any significant involvement of third-party companies (Moone, 2015). Nowadays, major parts of the construction process are frequently undertaken by third parties, commonly referred to as subcontractors. Segerstedt & Olofsson (2010) estimate that more than 75% of the final value of a typical building is produced with the help of subcontractors. A large proportion of the subcontractors manage their own flow of materials respectively without coordinating it with the other actors, greatly increasing the difficulty level of the logistics management (Robbins, 2015). Cooperation is thus fundamental in order to ensure a fluent building process, especially in larger project, where many different actors operate at the same time (Sobotka, et al., 2005). Furthermore, Sobotka, et al., (2005) suggest that the implementation of a precise centralised logistics system to coordinate the material deliveries, particularly when operating in city centres with time and space restrains, would prove to be beneficial and reduce conflicts.

Sobotka, et al., (2005) states that construction logistics can be considered in a wide range of aspects, e.g. on-site logistics, meaning the organisation of building materials on the construction site, or supply logistics, being the management of the deliveries of the construction materials to the building site from the suppliers. In 2005, it was noted that underutilised vehicles having to wait due to poor scheduling, unavailable material, immense stockpiling, poor coordination of activities and high amounts of damaged products are common features in the construction industry (Browne, 2015). Similarly, Agapiou, et al., (1998) reports how, already in 1983, it was highlighted that bad planning and poor logistics were causes of low productivity. Additionally, in 1994, The European Construction Institute stressed the importance of logistics to ensure productivity and efficiency, stating that "*material delivery to site is a critical, productivity related, aspect which demands the introduction of a carefully developed system of monitoring and control as early as possible*" (European Construtión Institute, 1994, p. 9). Without said

system, which precisely schedules the delivery of the materials according to their use, there is a high risk that material is stored on-site under poor conditions for longer periods of time, ultimately resulting in additional costs.

The importance of a well-working construction logistics system is also highlighted by Arbulu & Ballard (2004), who consider the construction process as a succession of steps that are dependent on the delivery of the necessary materials, but are at the same time dependent of the completion of previous steps. This becomes clear when looking at construction using off-site production. The construction industry has seen an increase in construction with prefabricated elements, which allow the construction process to progress much quicker than with more traditional construction methods (Robbins, 2015). The main benefit is that, instead of having to construct the elements on site, the elements are manufactured off-site before being delivered to the construction site and lifted into place. However, this further increases the importance of planning and coordination as the elements must not only be delivered on time, but also in a specific sequence. Thus, the process becomes heavily dependent on previous steps, putting pressure on both the factory and the transportation company to deliver on time (Robbins, 2015). This is visualised in Table 2-1 and Figure 2-1, showing how a relatively simple process that requires 10 interdependent steps to be completed has 90% of probability to be completed in time if each step has a 99% probability to be delivered in time (Arbulu & Ballard, 2004). This probability falls rapidly if the probability of each step to be completed according to schedule time decreases to 95%, 90% and 75%. In those cases, the probability that the entire project is completed in time falls to 60%, 35% and 6% respectively. Arbulu & Ballard (2004) continue stating that, in reality, a 75% probability that each step of a construction process is delivered on time is quite optimistic, yet the percentage of project that are delivered on time is higher than 6%. This is possible because of the extensive use buffer times by the construction project managers. Buffer times are however to be considered as a waste of time and resources thus every project should aim to reduce those to a bare minimum, thanks to a well-planned construction logistics system.

Table 2-1 – The probability of finishing a set of interdependent tasks on time, displayed in a table (Arbulu & Ballard, 2004).

	Psuccess			
# of SS*	99%	95%	90%	75%
1	99%	95%	90%	75%
2	98%	90%	81%	56%
3	97%	86%	73%	42%
4	96%	81%	66%	32%
5	95%	77%	59%	24%
6	94%	74%	53%	18%
7	93%	70%	48%	13%
8	92%	66%	43%	10%
9	91%	63%	39%	8%
10	90%	60%	35%	6%
11	90%	57%	31%	4%
12	89%	54%	28%	3%
13	88%	51%	25%	2%
14	87%	49%	23%	2%
15	86%	46%	21%	1%
16	85%	44%	19%	1%
17	84%	42%	17%	1%
18	83%	40%	15%	1%
19	83%	38%	14%	0%
20	82%	36%	12%	0%

(*) SS= Supply Systems

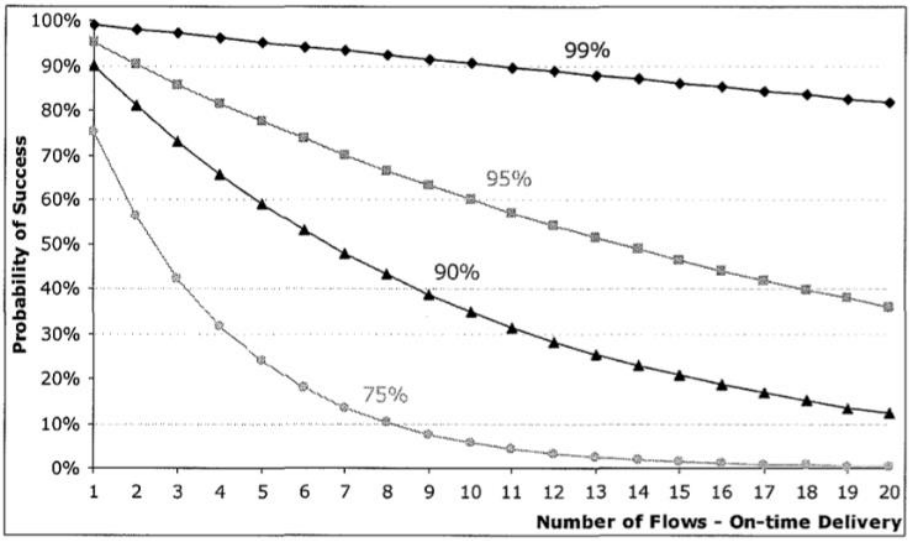


Figure 2-1 – The probability of finishing a set of interdependent tasks on time, shown as graphs (Arbulu & Ballard, 2004).

2.1.1 The cost of construction logistics

Logistics has typically been seen as a necessary evil that merely increases the costs, rendering contractors oblivious to the positive economic impact that a well-executed logistics operation can induce (Rushton, et al., 2014). A construction site has a large quantity of deliveries over the course of the project, and typically a lot of material handling as well. For larger projects, several years of planning might be required before construction is initiated (Browne, 2015). Once initiated, managing the flow of materials is crucial in order to maintain an efficient construction process, as poor on-site logistics can have impact on both cost, quality, time and safety (Browne, 2015). However, in the construction industry, logistics rarely has the same focus as in other industries; it is somewhat taken for granted (Lundesjö, 2015). Subsequently, the required logistics tasks are seldom clearly identified, thus being assumed to be included without additional cost (Lundesjö, 2015).

The costs of logistics include storage, stock/inventory, handling, transportation, packaging and administration (Browne, 2015), and can typically correspond to between four and ten percent of the selling price of a product (Ying, et al., 2018). Measuring and assigning these costs to products can however be difficult. For example, when purchasing construction material, the material is typically delivered to the site free of charge (Olsson, 2000). The cost of delivery is thus concealed in the price of the material, making it difficult to see that both a product and a service has been purchased. Ying, et al., (2018) state that 39-58 percent of logistics costs in consumed by transportation, and that such invisible logistics costs are a major barrier to being aware of your logistics costs.

2.2 Construction Logistics Plan

A key factor in achieving efficient logistics is to plan ahead. One way to plan in construction is to establish a *Construction Logistics Plan*, commonly referred to as CLP, which is a document that the main contractor produces, that should include both challenges and opportunities identified in the project (Robbins, 2015). Furthermore, the CLP should focus on the core logistics aspects, such as reception, storage, distribution of materials and waste management (Robbins, 2015). Brown (2015) states that the CLP is constantly growing in importance as the authorities administering development permissions have a significant interest in how major projects are planned and conducted, as they themselves are pressured by some of the stakeholders, e.g. local residents and businesses. However, despite the importance, CLP's are currently not widely used (Robbins, 2015).

There are two kinds of CLP's – Outline CLP and Detailed CLP (Transport for London, 2017). The Outline CLP is produced in the planning/design stage and is handed in with the planning application, thus only details that are available in the planning stage are required (Transport for London, 2017). An extensive Detailed CLP is then produced in the pre-construction phase and should be updated continuously throughout the construction phase as the conditions are changing (Transport for London, 2017). The length and coverage of the CLP also varies with the complexity of the project, but it needs to be worked out in a way that it is easy to understand and should not contain much new information (Croydon Council, 2015). Essentially, it should include well-familiar activities that you just might not have written down (Croydon Council, 2015). Transport for London (2017) suggests the following structure when producing a CLP:

- Introduction – General information about site, e.g. name of developer, project scope, operating hours.
- Situation, challenges and considerations – The current situation in the area, identified challenges and possible changes to local infrastructure.
- Construction process and approach – A construction programme diagram for all phases of construction, along with a description of the intended construction approach.
- Routing of vehicles and access to site – Which routes the construction vehicles are going to take and how to access the site.
- Impact reduction strategies – Strategies to minimise the impact of the construction project on the surrounding community and infrastructure.
- Vehicle movement estimations – An estimation on the amount of construction vehicles needed during the project, and how the vehicle flow will vary with the construction phases.
- Application, monitoring and revising – How the CLP will be implemented in the project and how the construction process will be monitored for future revising of the CLP.

2.3 Lean Production

In the 1980s, starting from the Henry Ford's concept of continuous flow of production, Eiji Toyoda and Taiichi Ohno developed a new production system denominated Toyota Production System or *Lean Production* (LP). The aim of LP was to decrease production cost without sacrificing the quality of the end product or by increasing the production volume. Cost cutting could instead be achieved by striving to eliminate waste (Gao & Low, 2014). Developing Lean Production, in his book *Toyota Production System*, Ohno (1988) identifies seven different kind of wastes that can occur in the manufacture process. Those are respectively *overproduction* of excess inventory before it is needed, *waiting* as a waste of time not used in adding-value activity, unnecessary *transportation* of goods along the production line and the supply chain, *over processing* of the final product in non-value adding ways for the costumer, excess *inventory* of raw material of final product, unnecessary *movement* of the workers during the production process and finally the production of *defect products*.

In order to reduce these wastes, Ohno bases LP on two pillars, as shown in Figure 2-2: *Just-in-Time* (JIT) and *Autonomation* (Jidoka). As explained by Gao & Low (2014), JIT focuses on trying to eliminate waste by reducing storage and waiting time to the bare minimums while carrying on the work according to a well-defined and precisely planned schedule. In other words, according to the JIT principles, deliveries along the supply chain of the manufacturing process should handle only the materials that are needed, only when they are needed, minimising the size of the inventory. *Kanban* is an LP technique that consist in pulling material to the production line only when required by the workers and can be adopted to LC. This technique could reduce on-site inventories and ensure that materials are pulled to the construction site only according to necessity.

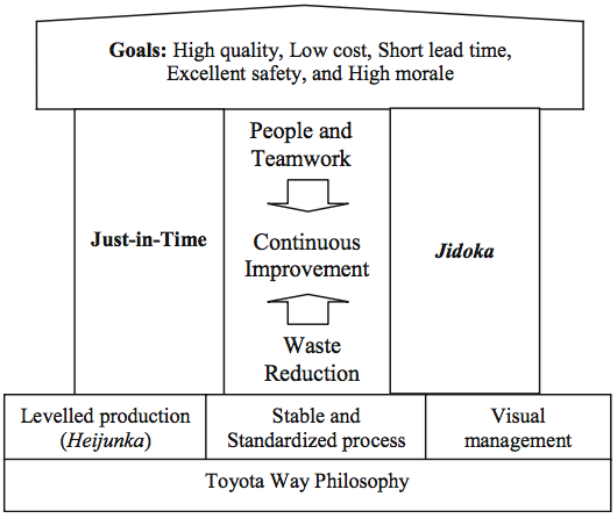


Figure 2-2 – A visualisation of the methodology of Lean production (Gao & Low, 2014).

Koskela (1992) further analyse this philosophy and summarise it in 11 practical principles, that should be applied to implement a LP process. These principals are:

1. Decrease the amount of non-value adding activities.
2. Increase value by systematically considering the requirements of the customers.
3. Decrease the amount of variability.
4. Shorten the cycle time.
5. Decrease the number of parts, steps and linkages.
6. Enhance the flexibility of the output.

7. Enhance the transparency of the process.
8. Control the whole process.
9. Implement continuous improvement practices.
10. Balance the improvement between flow and conversion.
11. Implement practices for benchmarking.

Finally, already in the beginning of the 90's, in their now famous book "*The machine that changed the world"*, Womack, et al., (1990) state the superiority of the Lean manufacturing process compared to the traditional production methods. Womack, et al., (1990) highlight the LP advantages of granting higher quality and flexibility of the final product, less time and material waste and smaller inventories, while at the same time LP also requires fewer human resources, less space and fewer investments.

2.4 Lean Construction

The successful outcomes that the implementation of the lean methodology have shown in the manufacturing industry since its introduction has led to many efforts in order to adapt those methodologies to the construction industry (Gao & Low, 2014). Already in 2002, Koskela, et al., defines *Lean Construction* (LC) as *"a way to design production systems to minimize waste of materials, time, and effort in order to generate the maximum possible amount of value",* (Koskela, et al., 2002, p. 211). However, Gao & Low (2014) argue that many studies highlight how the construction industry has peculiarities that differ from the manufacturing industry and that for this reason the lean practices of the manufacturing industry cannot simply be copied and implemented as they are to the construction industry. The most noticeable differences among those highlighted by Gao & Low (2014) are:

- the project-based nature of the construction industry, which translates in unique and relatively short-term projects;
- the relatively non-standardised construction materials that are usually supplied according to schedule (as opposed to standardised components supplied by orders for the manufacturing industry);
- the relatively high influence that environmental factors can have on the in-situ production which are negligible in factory production;
- the relatively low potential for automation and finally;
- the high degree of involvement of the owner of the project in the decision-making process.

According to Paez, et al., (2005), there are three main ways in which LC techniques can be elaborated. Namely, existing LP techniques can be brought and *adapted* to the LC context, existing LP techniques can be *expanded* and further developed in the construction context, and finally *whole new LC techniques* can be created. Furthermore, Paez, et al., (2005) identifies seven techniques that falls under those three categories, which is further described in the following sub-chapters.

2.4.1 Adapted Lean Production techniques

A tool that can be directly adapted from LP to LC in the implementation of a *Kanban system*. According to Arbulu, et al., (2003), a *Kanban system* can be used to manage the delivery of consumable, personal equipment and smaller hand and power tools to the construction site. As shown in Figure 2-3, in this system, materials are pulled on request from the workers from

"marketplaces", which is the material warehouse on site, to "satellite stores", locations closer to the workplace on site where materials are received and stored. In turn "marketplaces" pull those materials from external suppliers. Supplies are then delivered by external and internal "milk runs" vehicles. Internal "milk runs" periodically distribute materials to the satellite store on a *Just-in-Time* basis while external "milk runs" periodically collect those from the different suppliers. Both deliveries and requests of materials are implemented using different plastic bins for each worker or workstation with attached paper request and or documentations. Alternatively, occasional verbal material requests from the workers are allowed.

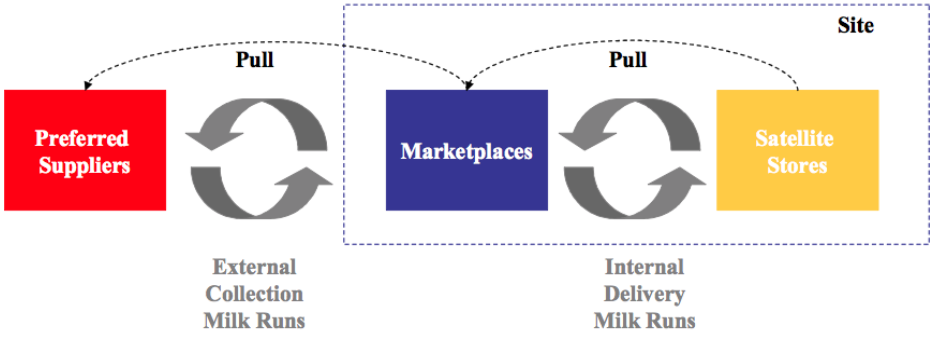


Figure 2-3 – The structure of a Kanban system (Arbulu, et al., 2003).

2.4.2 Expanded Lean Production techniques

The LP techniques that can be applied and further expanded to in LC that Paez, et al., (2005) identify are Concurrent engineering, Quality management tools and Visual Inspection.
Paez, et al., (2005) define concurrent engineering as the "parallel execution of different development tasks in multidisciplinary teams with the aim of obtaining an optimal product with respect to functionality, quality, and productivity" (Paez, et al., 2005, p. 238). In other words, the aim of concurrent engineering is to reduce time and resources waste by careful resource allocation and, when possible, parallel scheduling. In order to achieve this goal, time, quantities and risk assessments are crucial information to be had and buffer should be a planned cost. Moreover, Paez, et al., (2005) highlight the importance of early involvement of all the different actor of the project for a successful implementation of concurrent engineering.

Quality management tools are a set of defined controls that ensure product conformance. Those controls should be carried on by the workers themselves, using checklists in which quality goals are clearly defined. Finally, there is *Visual Inspection*, which aims to increase visualisation, both in planning on the construction site. In planning, this translate in making graphical schedules and milestones easy to visualise, while on the construction site, colour coding, visual signals and instructions can be used to achieve a smoother and more efficient workflow.

2.4.3 New Lean Construction techniques

The new LC techniques that Paez, et al., (2005) identify are *Plan Condition of Work Environment in the Construction Industry* (PCMAT), *Daily Huddle Meetings* and *Last Planner System* (LPS). The aim of PCMAT is to create a safe and healthy environment. To achieve this, a *Preliminary Hazard Analysis* (PHA) is conducted and safety activity are integrated in the daily schedule. Finally, the accomplishment of the safety target is evaluated daily, using the feedback of the workers (Paez, et al., 2005). *Daily Huddle Meetings* is a Scrum practice that has been integrated in *Lean Construction* (Paez, et al., 2005). Those consist of short and fast

paced standing meetings at the beginning of each working day, in which each member updates the team about what has been accomplished, what is to be done during the day and what are the priorities and crucial activities of the day. Thanks to *Daily Huddle Meetings*, it is easier to keep track of the progress the team and administrate the work to better cope with the unpredictable nature of the work on the construction site. Finally, *Last Planner System* is described by Ballard (2000) as a tool based on resource pulling to effectively plan, manage and control the construction workflow. LPS is be further described in chapter 2.5.

Gao & Low (2014) suggest that in order to be successful, everyone involved in the implementation of LC need to be well aware of the long term benefit of this methodology and commit to it. However, Gao & Low (2014) also state that, according to different examples in the literature, when correctly implemented, LC can grant considerable improvement in regard of costs, productivity, quality, delivery time, plan reliability, working partners relations and workers satisfaction.

2.5 Last Planner System/Push and Pull

As previously discussed, one of the most prominent LC tools is LPS. In their survey, Cho & Ballard (2011) underline a parallel between project performance and the implementation LPS practices. But what exactly is LPS and how is it implemented in practice? This methodology was first proposed by Ballard in the year 2000 and aims to optimise planning focusing on what "*Should-Can-Will-Did*" happen (Ballard, 2000). Ballard bases his method in recognising that what *should* be does not always coincide with what *can* be done. The purpose of LPS is to decide on a short-term basis what *Will* be done try to breach the gap between what *Should* and what *Can* be done. Finally, what *Did* happen according to the plan is registered as a knowledge base for future plans. Practically, in LPS the *Master Schedule* is divided, as shown in Figure 2-4, in shorter schedules, *Phase Schedule*, which in turn is divided in *Look Ahead Plan* and the *Weekly Plan* (Cho & Ballard, 2011). At each stage, the plane is divided in smaller and smaller time spans, and at the same time they gain a higher and higher level of detail. This allow for a higher degree of flexibility compared to the Master Plan alone, and allow to cope more efficiently with the variability of the work on site (Hamzeh & Bergstrom, 2010).

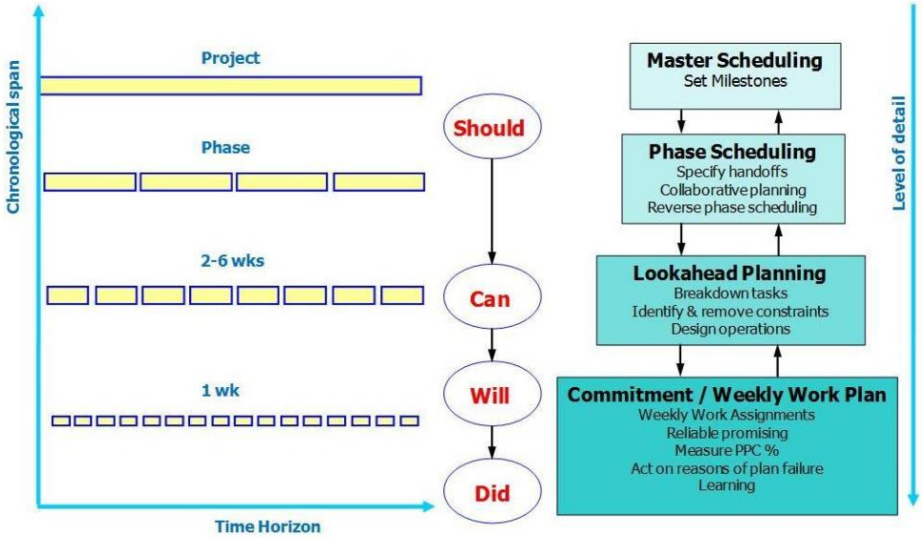


Figure 2-4 – The different levels and stages of a Last Planner System (Hamzeh & Bergstrom, 2010).

A follow-up is held on a weekly basis to check which assignments were completed the previous week, what assignments are to be carried out during the upcoming week and what is required

to complete each assignment. Consequently, the resources required for the assignments are scheduled so that they are in the right place when needed. The weekly assignments are planned together with the person(s) responsible for the work on site, who only take on the amount of work they reckon they can complete in the given time. Concurrently, they commit and are responsible to complete the assignment in the given week (Hamzeh & Bergstrom, 2010).

LPS is based on two pillars: *Production Unit Control* and *Work Flow Control* (Ballard, 2000). The role of the first is to enable single assignment to be carried out correctly and according to schedule, while the second aims to implement the various assignments in the most efficient sequence, so that there are not any stoppages along the process. In first place *Production Unit Control* aim is to ensure that assignments are comprehensively defined, allocated in the right sequence, assigned the right amount of work hours and that all the required resources are in place. Secondly, *Production Unit Control* aims to control the planning system performance by monitoring the *Percentage Plan Complete* (as the percentage of assignment completed divided by the total assignment). Finally, *Production Unit Control* aims to investigate possible failures in the plan's implementation and understand their causes to avoid future failure. In this sense, Ballard (2000) identifies five main causes of failure in plan implementation:

1. Poor communication and distribution of wrong information such as uncompleted previous required assignment reported as completed.
2. Poor estimation of the quantity of work required of a given assignment.
3. Poor coordination in the use of shared resources such as machinery or communal space.
4. Reassignment of manpower due to shift in assignment priority order.
5. Design, product or material defect and issues incurred during assignment implementation.

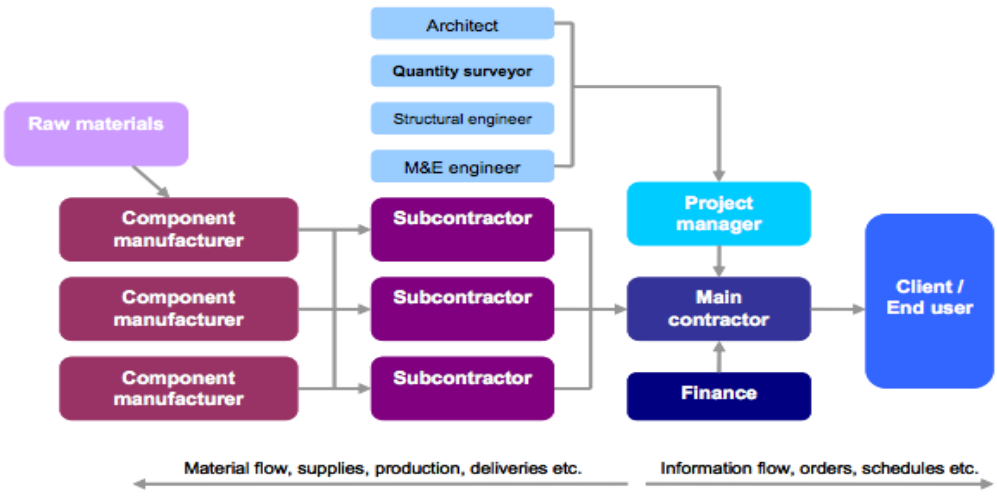
In the system proposed by Ballard (2000) *Work Flow Control* is the set of practices that coordinate the work across the different assignment. Most noticeably, in LPS the assignment that are identified from the analysis of the Master plan are subjected to constrain control, in which possible hinder to completion of the task are identified. Only assignments whose constraints have been resolved and are ready to be executed on time are then allowed in the lookahead planning, usually up to six weeks before the time of execution. The aim is to build up a backlog/pool of assignments that can be executed directly. In this way assignment are not *pushed* to the site from upstream. Instead planners can *pull* in the weekly schedule work that can be executed with no waiting time and to maintain this flow constant. Moreover, Ballard (2000) highlights how, in order to successfully plan the workflow, it is fundamental for planners to match workload to work capacity. Those two factors could change if time or resources pressure should arise. Nonetheless, they shall both be adjusted the new conditions accordingly.

Finally, Ballard (2000) underlines how creating a backlog of work ready to be executed could be seen as a contradiction to the LP methodologies, which prescribe a reduction of inventories and buffer. However, given the variability of the work on site, this is in reality an inevitable condition to ensure that assessments are executed on a *Just-in-Time* basis. Furthermore, in order to reduce work buffers, focus should instead lay in reducing work variability (Ballard, 2000).

2.6 Supply chain in the construction industry

As previously stated, subcontractors have become a common feature in construction projects, thus adding many stakeholders to the supply chain. Robbins (2015) even refers to a typical main contractor supply chain as 'enormous'. A key advantage of employing subcontractors is the specialist nature, i.e. the opportunity to engage workers with distinct areas of expertise in the project (Moone, 2015). When done properly, the companies in a supply chain can bring technical superiority to the project, along with improved efficiency, quality and delivery consistency due to experience in their area of expertise (Moone, 2015). However, trade-offs must be made when employing subcontractors. Employing new subcontractors might entail new innovative solutions, but also risks due to an increased uncertainty (Moone, 2015).

Figure 2-5 shows a highly simplified visualisation of a construction industry supply chain. Seeing that a construction project in the £20 – £25 million range could involve around 70 subcontractors, there is a high risk that the supply chain becomes fragmented (Department for Business, Innovation and Skills, 2013). Department for Business, Innovation and Skills (2013) also states that there are examples where a large proportion of said subcontractors account for less than 0.25% each of the final value, showing evidence of a fragmented supply chain. Coordinating a fragmented multi stakeholder supply chain is an extremely difficult task that puts a great deal of pressure on the logistics function (Robbins, 2015). The notion that many construction projects take place in environments that are characterised by both physical and time-related constraints further increases the difficulty. Despite this, Robbins (2015) states that a majority of construction sites manage their logistics in "the traditional way", i.e. ad hoc coordination on site, ignoring both off-site logistics and resource efficiency amongst the actors involved. Consequently, the construction industry has repeatedly been criticised for being inefficient and poorly coordinated (Robbins, 2015).



Note: This is a very simplified representation of construction supply chain. In practice a construction project may rely on tens of subcontractors and component manufacturers.

Figure 2-5 – A highly simplified construction industry supply chain (Department for Business, Innovation and Skills, 2013).

2.7 Supply chain management

Larson and Halldorsson (2004) state that it is difficult to clearly define the field of *supply chain management* (SCM) and distinguish between SCM and logistics. They point out that the relation between the SCM and logistics concepts can currently be seen from four different perspectives. In the *re-labelling* perspective, the SCM discipline coincide with logistics, and the two are de facto the same thing. The *traditionalist* perspective views SCM as a part of the logistics field. According to this view, SCM is the specific branch of logistics that is interested in operations that happens outside the firm's boundaries, such as the relation and coordination with other firms. The *unionist* perspective, on the contrary, states that logistics is a part of SCM, which is instead a broader discipline that include branches such as strategic planning, marketing, sales and information technology. Finally, the *inter-sectionist* perspective views SCM and logistics as different fields where the strategic aspects of each field are mutual (Larson & Halldorsson, 2004).

In this work, SCM is considered according to the *unionist* perspective, in compliance to the definition of SCM given by the Council of Supply Chain Management Professionals, who defines SCM as managing of logistics activities as well as the "*manufacturing operations, and it drives coordination of processes and activities with and across marketing, sales, product design, finance and information technology"* (Council of Supply Chain Management Professionals, 2013, p. 187). Additionally, the definition of SCM by Mentzer, et al., (2001) is also taken into account. According to this definition, SCM is the implementation of practices to strategically coordinate and manage "traditional business functions" within the firm and across different companies of the supply chain in order to increase the performance of the single firm as well as the whole supply chain in the long term (Mentzer, et al., 2001).

According to Ekeskär (2016), the construction sector presents specific condition for the implementation of SCM. Construction sites can be seen as temporary factories with related temporary and complex supply chains. Furthermore, in a construction project, SCM needs to address logistical issues related to the handling of materials, but also issues that are more peculiar for this sector such as managing heavy machinery (lifter, excavators, cranes etc.), equipment (construction elevators and scaffoldings) and also labour, managing contractors and subcontractors (Ekeskär, 2016). Additionally, the complexity of SCM in construction is further enhanced by the nature of the construction site, which can be seen as the place where the *logistics process* and the *product development process* needs to coincide in a synchronised manner, as shown in Figure 2-6. In this regard SCM should strive to improve communication between these two processes to promote a coordinated workflow (Ekeskär, 2016).

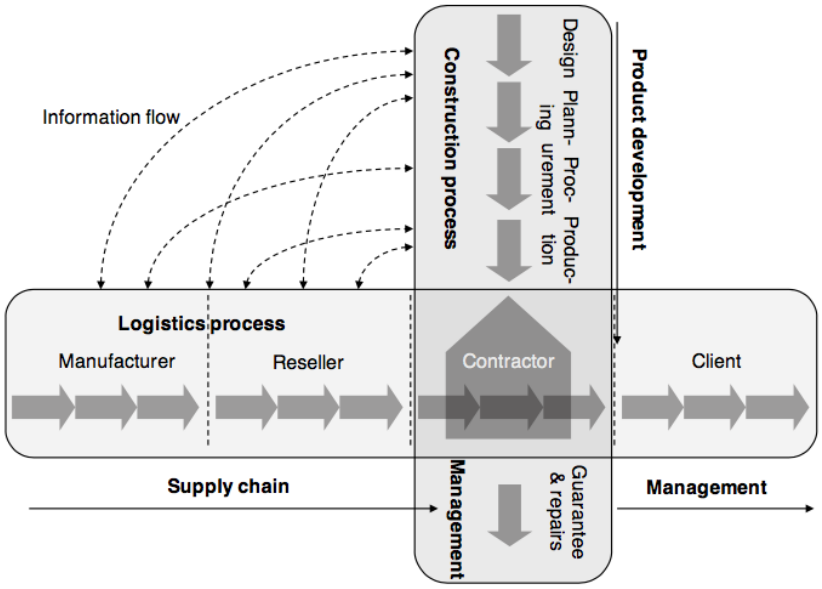


Figure 2-6 – The synergy between the construction process and the supply chain (Ekeskär, 2016).

According to Vrijhoef & Koskela (2000), SCM can, as seen in Figure 2-7, assume four different roles in relation to the construction industry. Firstly, SCM shall help improve the interaction and coordination of the activities on the construction site with the supply chain. Vrijhoef & Koskela (2000) suggest that the implementation of LPS methods could prove beneficial to this scope. Secondly, the role of SCM is to improve the supply chain itself, striving to adopt more efficient and reliable processes. Next, SCM, when possible, should seek to move non-value-adding activities, higher up in the supply chain with processes such as pre-assembly and pre-fabrication. Finally, the fourth role of SCM is to try integrating the whole supply chain with the entirety of the on-site process, fulfilling all of the previous three roles (Vrijhoef & Koskela, 2000).

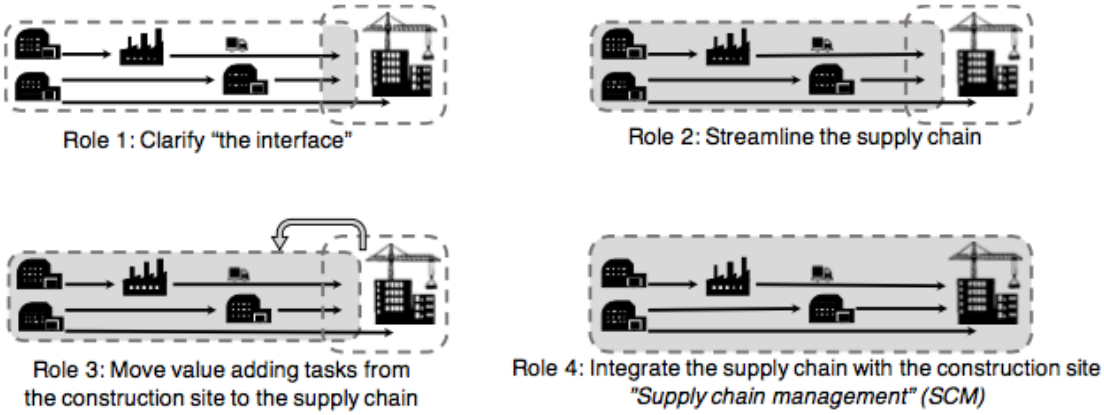


Figure 2-7 – The different roles of construction industry Supply Chain Management (Vrijhoef & Koskela, 2000).

2.8 Third-Party Logistics

Marasco (2008) defines *Third-Party Logistics* (TPL) as "*an external organisation that performs all or part of a company's logistics function*" (Marasco, 2008, p. 128). In other words, TPL are specialised logistics firms that are hired by companies in order to outsource parts or the totality of the logistics processes. Services typically offered by TPL can involve management of the inventory, including warehousing and transportations and management of information, meaning the planning and tracking of the material distribution. However, those services can also span to operations of off-site pre-assembly or the redesign of the whole supply chain system (Ekeskär, 2016). Being a part of *Supply Chain Management*, both TPL and SCM share mutual aims, namely cost reduction and increase of customer value and satisfaction, in order to generate a competitive advantage (Ekeskär, 2016). The possibilities of improvement in this sense are also identified by Aguezzoul (2014) as the main forces that push for the implementation of TPL, while main risks are to be associated with bad relationships and cooperation between TPL firms and the hiring company.

According to Ekeskär (2016), the relatively low level of knowledge of *Supply Chain Management* in the construction industry has, in recent years, helped the blooming of a new market for specialised construction TPL firms. The implementation of TPL has been observed in three main forms:

- The TPL firm is responsible only for the on-site coordination and handling of the construction materials, in this paper also referred to as OSH (On-Site Handling) (Lindén & Josephson, 2013; Gadde & Dubois, 2012). This kind of solution can typically be implemented by scheduling deliveries outside of operating hours, allowing both the craftsmen and the TPL firm to work more efficiently (Lindén & Josephson, 2013).
- The TPL firm is responsible for the incoming materials and manages a decentralised warehouse, or CCC, where construction materials are securely stored (Gadde & Dubois, 2012). Materials are successively pulled to the construction site when required (Gadde & Dubois, 2012).
- The TPL firm plans, coordinates and manages the deliveries to the construction site through a *Delivery Booking System* (DBS). Deliveries are conducted through a routed system where incoming deliveries are received on a JIT basis (Lindén & Josephson, 2013). Upon arrival, the delivery vehicle must get clearance from a checkpoint station before proceeding to a specific unloading area (Lindén & Josephson, 2013).

Ekeskär (2016) highlights how the implementation of TPL in the construction industry is a relatively new phenomenon and, for this reason, only few studies have been made. However. promising cases have been observed. Sobotka and Czarnigowska (2005) reports how outsourcing logistics operations to a specialised firm can yield a reduction in transportation and storage, with consequent cost reduction. Furthermore, Lindén and Josephson (2013), when comparing traditional construction project to projects where TPL solution have been implemented (namely having a TPL firm responsible for on-site logistics as well as planning and handling of the deliveries), concluded that the latter has a more effective solution, with decreased costs.

In their work, Ekeskär & Rudberg (2016), through a literature review, identify driving forces and potential concerns that could drive or hinder the implementation of TPL and divide them into *strategic*, *financial* and *operational* issues in accordance with the categorisation of "*benefits and risks of outsourcing*" made by Selviaridis and Spring (2007, p. 129). Said division can be seen in Table 2-2.

Table 2-2 – The driving forces and concerns of Third-Party Logistics implementation (Ekeskär, 2016).

	Driving forces	Concerns
Strategic issues	• Possibility to focus on core competencies[2, 4] • Possibility to exploit external logistical competence[4] • Enhanced flexibility to changes in product, requirement and demand[1, 2, 4, 5] • Improved customer satisfaction[1, 4, 5, 6] • Possibility to implement change and restructure the supply chain[3, 4, 5, 6] • Increased and faster learning[3]	• Loss of control[2, 4] • Loss of in-house capability[4, 6] • Loss of customer contact and lack of responsiveness to customer needs and demands[4] • Risk of limited acceptance by employees[2]
Financial issues	• Lower costs (including labour and equipment maintenance)[1, 2, 3, 4, 5, 6, 7] • Reduced capital tied-up in assets[1, 2, 4, 5, 6] • Exploiting economies of scale and scope[3, 4]	• Fear of unrealistic fee structure[4] • Lack of knowledge of own internal logistics costs[4]
Operational issues	• Reduced inventory levels[2, 4] • Better lead-time performance[2, 4, 6, 7] • Reduced order cycle times[2, 4] • Improved delivery service[1, 2, 4, 5, 6, 7] • More efficient operations[3]	• Fear of inadequate TPL provider expertise and inadequate employee quality[2, 4, 7] • Inability of TPL provider to deal with special needs and products[4, 7] • Inability of TPL provider to deal with emergency circumstances[4] • Risk of poor service performance and disruptions in inbound flows[2, 4] • Performance of TPL providers IT system[2, 4, 6, 7]

1: Skjoett-Larsen (2000)
2: van Laarhoven *et al.* (2000)
3: Hertz and Alfredsson (2003)
4: Selviaridis and Spring (2007)
5: Marasco (2008)
6: Liu and Lyons (2011)
7: Aguezzoul (2014)

2.8.1 Strategic issues

In their framework, Ekeskär & Rudberg (2016) identify different strategic factors that can stimulate the implementation of a TPL solution. According to van Laarhoven, et al., (2000) the most relevant factor is that, hiring TPL firms to implement and manage the logistics system, companies are allowed to focus and concentrate their efforts toward their core activities. Additionally, Ekeskär & Rudberg (2016) highlight how, according to different literary sources, TPL firms are often hired in an attempt to increase production flexibility, and to increase customers service. Moreover, hiring a TPL firm allow companies to make use of the TPL firm's expertise, both in managing the logistics works, as well as in making changes to the whole structure of the supply chain (Selviaridis & Spring, 2007). Lastly, according to Hertz & Alfredsson (2003), being in contact with the TPL´s expertise would speed up the learning process of the companies, regarding logistical practices.

On the contrary, Ekeskär & Rudberg (2016) report how strategic factors, that represent concerns for the hiring company, could hinder the adoption of a TPL solution. Firstly, according to Selviaridis & Spring (2007), companies are concerned that a badly implemented TPL solution

could lead to a decreased contact with customers, which in turn could cause a decrease of responsiveness to their demands. Moreover, companies are concerned that, relying uniquely on the TPL's competence, a loss of control over the project could occur, decreasing the capabilities that are already present in the company (Selviaridis & Spring, 2007). The last strategic factor that could be concerning for the hiring company is the friction that could arise between the TPL firm and the hiring company's employees, due to the adoption of new practices (van Laarhoven, et al., 2000).

2.8.2 Financial issues

Cost reduction, as a driving force towards an adoption of a TPL solution, is common in all the literary sources considered by Ekeskär & Rudberg (2016). According to van Laarhoven, et al., (2000), cost reduction is the strongest and most common reason to adopt a TPL solution. Van Laarhoven, et al., (2000), continues to highlight the importance of cost reduction for the hiring companies, stating that cost reduction below expectation is one of the most common reasons for terminated relationships with TPL firms. Another financial reason to implement a TPL solution, identified in the literature by Ekeskär & Rudberg (2016), is the reduction of capital tied up to assets and investments in equipment, including labour and maintenance (Selviaridis & Spring, 2007). Finally, the last financial benefit that could drive the adoption of TPL is, according to Selviaridis & Spring (2007), the possibility for TPL firms to use economy of scale to distribute, thus reducing the logistics costs.

The financial concerns that could discourage companies from hiring TPL firms, as identified by Ekeskär & Rudberg (2016), is the worry that, doing so, the company could lose track over the logistics costs, and that TPL firms could implement a structure of unrealistic fees, undermining cost reduction.

2.8.3 Operational issues

In the literature considered by Ekeskär & Rudberg (2016), the most common operational benefit that companies try to reach by hiring TPL firms is to improve the delivery service and reduce the lead-time, meaning the time between placing and order and having said order delivered. Other advantages that companies wish to achieve by adopting a TPL solution are, according to Selviaridis & Spring (2007), the reduction of orders cycle time, meaning the possibility to place orders more frequently, and the consequent reduction of inventory levels on site. Finally, Hertz & Alfredsson (2003) suggest that, as a consequence of a well-planned TPL delivery system, the hiring companies might obtain a more efficient building operation.

According to Ekeskär & Rudberg (2016), the main operational aspects that concerns companies when hiring a TPL firm are the risk of deficient competency from the TPL firms, inadequate TPL employees or poorly performing IT systems. Furthermore, Selviaridis & Spring (2007) highlights how the hiring companies are afraid that TPL firms could display low levels of flexibility when it comes to dealing with special requests, extraordinary deliveries or emergency circumstances (e.g. short note orders). Finally, the last operational concern suggested by Selviaridis & Spring (2007) is that the TPL firm could deliver a poor service, which in turn could create disturbances in the flow of incoming deliveries.

2.9 Construction Consolidation Centres

In the construction industry it is somewhat common practice to order material in larger quantities than necessary, just in case, and have the material delivered before it is needed, due to uncertainties in delivery (Robbins, 2015). Subsequently, the material is typically stored on site under poor conditions and has to be handled multiple times, both of which is wasteful and increases the risk for damage (Robbins, 2015). Lundesjö (2015) mentions that up to 25% extra material can be ordered to cover for damage, theft or the material simply being lost on site. One way to tackle this is to implement the use of a *Construction Consolidation Centre*, commonly referred to as CCC, which is essentially an off-site facility where small deliveries of material are stored in a controlled environment for short periods, ideally no more than 14 days in order to maintain efficient usage of the storage area, before being delivered to the construction site (Sullivan, et al., 2010). The general principles of a CCC can be seen in Figure 2-8.

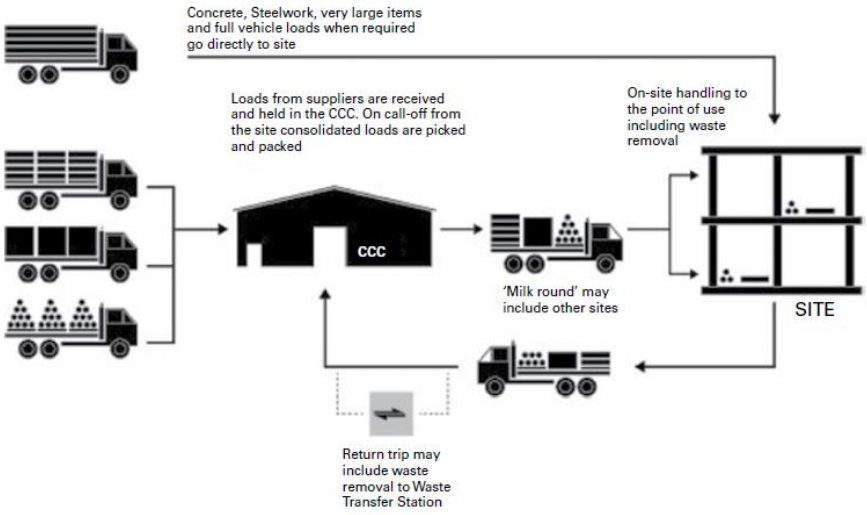


Figure 2-8 – The general principles of a Construction Consolidation Centre (Lundesjö, 2015).

One central point in using CCC is to reduce the amount of material stored on site (Lundesjö, 2015). Thus, the material delivered should only cover the demand for one or two days, forcing the contractors to plan their demand a few days ahead in a *Last planner* fashion (Lundesjö, 2015). Subsequently, Lundesjö (2015) mentions that several main contractors experience an increased flow in the construction process. It is also possible to implement a *Kanban* system for consumables, that automatically keep track of stock levels and order when the stock is low (Lundesjö, 2015). In order to avoid having several small deliveries to the construction site, the material is delivered from the supplier to the CCC instead. A team operating the CCC then verify that the delivery is free from damage, and that it contains the correct material in the right quantities (Lundesjö, 2015). Upon confirmation, the material is then unloaded, stored and kept track of under controlled conditions (Sullivan, et al., 2010). As the quantities and condition of the material is checked upon arrival, there is a few days' buffer to correct any deviations before the material is actually needed on site, allowing a steadier production flow. Similarly, the CCC can work as a buffer for materials that are produced abroad or have an exceptionally long lead time (Sullivan, et al., 2010). Once the material is needed on site, several small deliveries are transhipped into larger deliveries before being distributed, resulting in fewer deliveries to site (Sullivan, et al., 2010). This is especially beneficial at urban construction projects, where the surrounding roads are easily congested (Sullivan, et al., 2010). It is possible to use one CCC for several projects in the same area. An example of this is the London Construction Consolidation Centre (LCCC) which is located in the outskirts of London and served four overlapping

construction projects in central London between 2005 and 2007 as a pilot (Sullivan, et al., 2010). The results showed, inter alia, that the number of construction vehicles delivering to the LCCC projects entering central London decreased by 68%, the average supplier delivery driving time was reduced by two hours, the CO2 emission was reduced by 75% and the labour productivity on these sites increased by 30 minutes per person and day (Lundesjö, 2015).

To maximise effectivity, the CCC can also be complemented with having a logistics team on the construction site that receives the material and transport it to where it is needed on site, i.e. OSH (Lundesjö, 2015). This means that the skilled craftsmen can proceed with their work, rather than having to handle incoming material (Lundesjö, 2015). However, not all deliveries go to the CCC. Bulky items and fully utilised vehicles where the materials are all needed at once can bypass the CCC and deliver directly to site, as unloading and reloading the very same shipment just make for extra work (Lundesjö, 2015). As the early stages of a construction process involves high quantities of products with a low weight to volume ratio, typically steel and concrete, the need for CCC's initially is quite low, but becomes higher towards the later stages, especially the fit-out stages, i.e. when plumbing and electrical fixtures are installed (Lundesjö, 2015).

A CCC should be located in connection to larger roads, both in order to be easily accessible by delivery vehicles, but also to unburden the smaller roads from heavy traffic (Lundesjö, 2015). Sullivan, et al., (2010) suggest that a CCC ideally should be located at maximum 10 km distance from site, while Lundesjö (2015) proposes that the site should be reachable with a 30-45 minute drive from the CCC. While traditional delivery methods often involve very uncertain delivery times, a well-located CCC can deliver to site with a 15-minute accuracy, making it easier to be ready with the necessary unloading equipment on site upon arrival (Lundesjö, 2015).

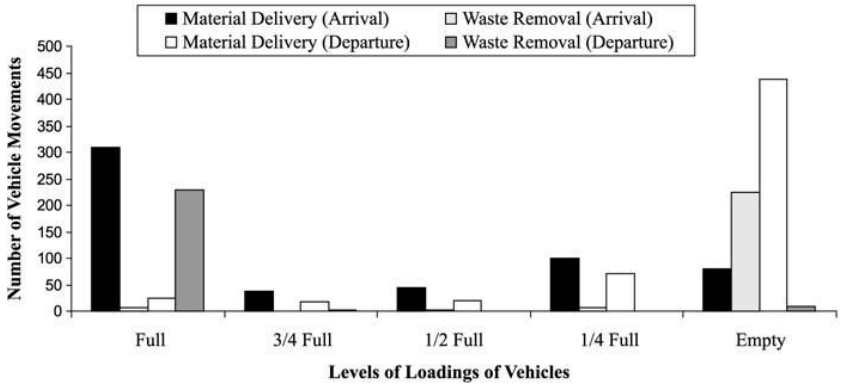


Figure 2-9 – Loading levels of vehicles entering and leaving a construction site (Shakantu, et al., 2008).

In addition to all the material deliveries to a construction site, construction also generates large quantities of waste that needs to be removed. According to Shakantu, et al., (2008), 100 million tonnes of construction waste is generated annually, only in the UK. Furthermore, Shakantu, et al., (2008), has studied seven different South African construction sites for a period of three months and noticed that there is considerable amount of empty waste removal vehicles and delivery vehicles entering and leaving the sites respectively, as shown in Figure 2-9. Lundesjö (2015) claims that the proportion of delivery trucks leaving empty typically could be as high as 80%. Thus, there is a high level of underutilisation in the sites' vehicle flows, leading to an unnecessarily high number of vehicles entering the sites. By using the CCC to remove excessive packaging prior to delivery to site, less waste removal trucks would have to enter the site (Lundesjö, 2015). In order to further minimise the waste generation, reusable packaging could be used. Previous attempts to implement reusable packaging has however often failed, as it has

been difficult economically to manage the return logistics of the packaging (Lundesjö, 2015). However, using a CCC, the delivery vehicles could bring the packaging back to the CCC after unloading, where the supplier vehicles in turn could pick up the packing after delivering their materials (Lundesjö, 2015). Thus, the utilisation of delivery vehicles could be more efficient, decreasing the accumulated number of vehicles needed at the construction site. Using CCC's does add to the logistics costs, as it is an additional point of stockholding requiring labour and handling (Browne, 2015). In fact, CCC is the most expensive and resource-intensive way of handling the flow of materials (Robbins, 2015). Although, there are several reports from the 00's that highlight the potential advantages of using CCC's (Browne, 2015). However, despite the overall great feedback expressed in said reports, CCC's are used only occasionally in the construction industry (Lundesjö, 2015).

2.10 Delivery Booking System

Another way to organise the deliveries is to implement a booking system for scheduling the deliveries (Robbins, 2015). While the CCC focuses on consolidating deliveries, reducing the amount of delivery vehicles to site, a booking system has its focus on Just-in-Time deliveries (Janné, 2018). The system functions, as seen in Figure 2-10, by scheduling a time for delivery upon placing an order (Janné, 2018). When it is time for delivery, the delivery vehicle is directed to a checkpoint at, or in close proximity of, the construction site, where the delivery must be given clearance before proceeding to unload (Ekeskär, 2016). Similarly, waste removal and returns also go via the checkpoint (Janné, 2018).

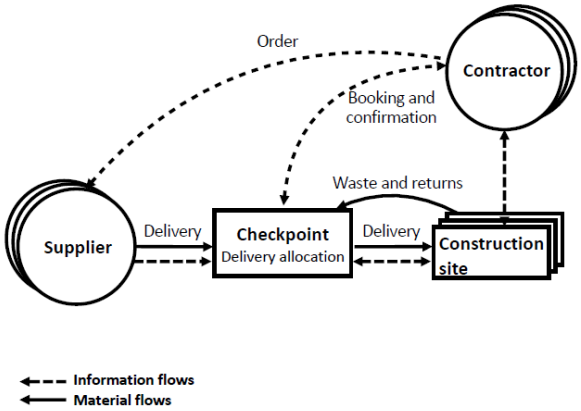


Figure 2-10 – The general principles of a Delivery Booking System (Janné, 2018).

However, when using this kind of booking system, it is difficult for the suppliers to meet the expectations of JIT deliveries (Robbins, 2015). For a booking system to be successfully implemented, the construction site must be easily accessible for the delivery vehicles, in order for the driver to make a reliable estimation of the driving time (Robbins, 2015). Otherwise, the driver risk being delayed and, subsequently, arrive late for the delivery. Alternatively, the construction site must offer sufficient parking where the drivers can wait for unloading (Robbins, 2015). There are several cases where neither of these are fulfilled, forcing the driver to circle the nearby roads for up to two hours in order to deliver on time, and while the delivery is performed on time, the circle driving not only adds to the logistics costs, but also affect the local environment (Robbins, 2015). The booking system is further addressed in chapter 4.

3 Method

This chapter explains the research methodology used for conducting this thesis, e.g. *Research design, Literature research, Empirical research, Ethical conduct* and *Trustworthiness.*

3.1 Research design

The thesis has been conducted as a qualitative study, with an abductive research approach. As seen in Figure 3-1, step 5a and 5b makes the qualitative study partially iterating, allowing for slighter adjustments to the initial research question(s) along the way. The first step of both the inductive and the abductive research methods is a real-life observation, but the abductive research was considered most suitable as it works in an iterative fashion, with Kovács & Spens (2005) stating that "*abductive reasoning starts at the point at which an observation in the empirical research does not match these prior theories*" (Kovács & Spens, 2005, p. 139). An iterative process then starts in matching the theory to said observation (Kovács & Spens, 2005). The research process started by phrasing a set of research questions, based on prior knowledge. A literature study was then initiated, running parallel to the empirical research. The empirical research helped bring better understanding to both work practices and concepts, making way for adjustments to the direction of both research questions and literature study.

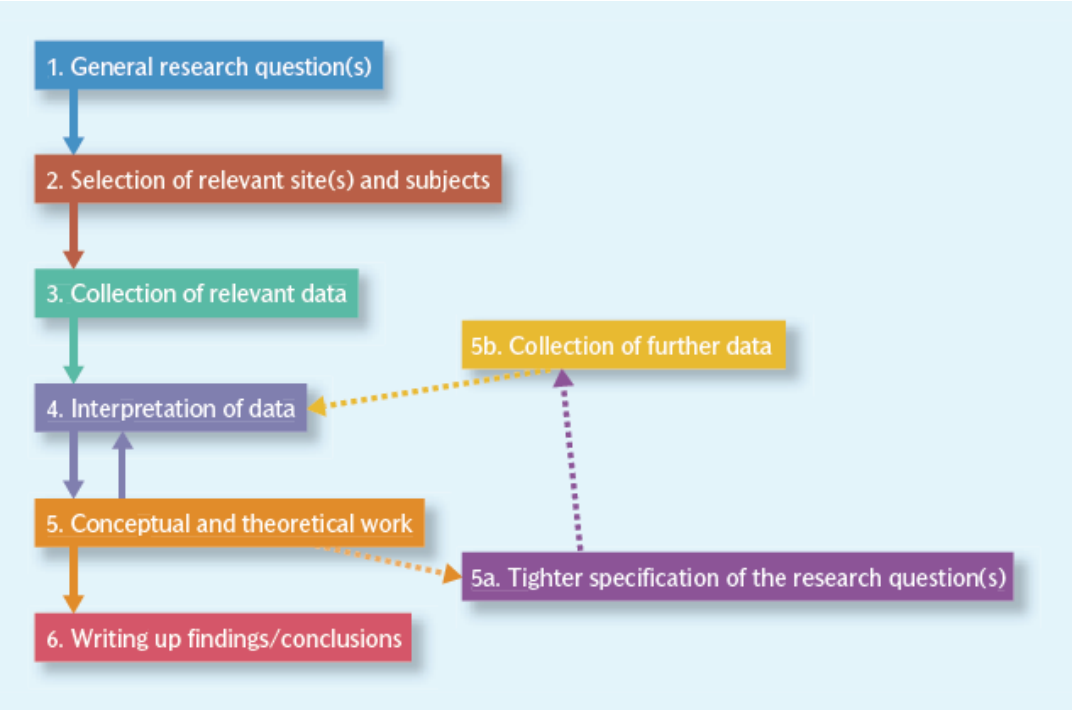


Figure 3-1 – The main steps of a qualitative study (Bryman, 2012).

3.2 Literature research

Prior to examining how Company A has shaped their logistics system, a literature study was initiated in order to get an understanding of what could be considered the current state of the art practices, based on literature findings. The literature study has then partly been overlapping the empirical studies. Initially, the literature was aimed at obtaining a broad knowledge, in order to get an understanding of which central concepts could be relevant for the purpose of the thesis. These concepts subsequently formed the outline of the theory chapter. Thereafter, a more detailed study of said concepts was made to constitute the theory chapter. Minor iterative

changes to the theory outline has also been made along the way. The theory chapter is mainly based on books, scientific articles and conference papers, and the main sources for finding literature has been Chalmers Library, Google Scholar and Scopus. While having strived to use recent and up-to-date sources, there are a few exceptions due to these sources being grounding to their respective topics. Central keywords used in the search for relevant literature are, inter alia, *'Construction logistics', 'Lean construction', 'Third-party logistics', 'Construction consolidation centre'* and *'Last planner'*.

3.3 Empirical research

Empirical data for this research were gathered in two main way. Firstly, in order to have an understanding of a TPL company's practices and their direct experiences of the construction industry, Company A was consulted. Secondly, a survey was submitted to people working in the construction industry with experience of engaging TPL companies, in order to collect their personal experiences. The survey can be seen in Appendix.

3.3.1 Company A consultation

In order to understand and map the current practices of Company A, different techniques were used to gather data. Among those, correspondence and interviews were conducted with employees of Company A. While correspondence was conducted in a structured manner, asking defined question that required delimited answer, the interviews were conducted in a semi-structured format. This to ensure to gather relevant information for the research but at the same time leave the interviewee the freedom to add on information that could be interesting for further research. Moreover, while subjects and questions treated in in the first interviews had a broader scope, in later interaction, after an analysis and comparison to the theory, those were more specific and focused defined issue. Furthermore, visits to a construction site where deliveries were managed by Company A were conducted in order to have a clearer picture of how their practices are implemented in reality. Finally, access to the Company A management software system was granted so that their delivery schedule could be observed.

3.3.2 Survey

To gather data regarding the direct experiences with the work of TPL companies, a survey was implemented. The aim of the survey was to evaluate if the cooperation with TPL company had proven to be beneficial or not, and to try to identify what are the real-life strengths and weaknesses of this cooperation. The survey was successively distributed to people in the industry, with pertinent experience of being TPL companies' customers. Contact information of the respondents were primarily gathered through social media, such as LinkedIn. Moreover, as the research delimitations include only the Swedish construction industry, the whole survey was conducted in Swedish language to facilitate a clear comprehension from the respondent. The survey can be seen in Appendix A.

The first section of the survey was formulated to help categorise the source of the answers. In this section the respondent was asked to specify what kind of project he or she involved was involved in when cooperating with the TPL company (e.g. school, hospital, housing, offices etc.) and what role the person was holding the project (e.g. project manager, on-site manager etc.). In this way, the survey intended to reach roles with point of views in different projects to gather the broadest variety of experiences possible. Furthermore, the respondent was asked to specify what kind of work was performed by the TPL company and how this was organised.

The three possible alternatives were selected according to the classification of TPL companies by Ekeskär & Rudberg (2016), presented in chapter 2.8. A fourth "do not know" option was added for those respondents who could not categorise the TPL company's work according to this classification.

In the following three sections of the survey, 25 statements were presented to the respondent. The respondents were asked to express to which degree he or she agree or disagree with the given statement. The presented statements were directly based on the table of driving forces and concerned for the implementation of TPL that Ekeskär & Rudberg (2016) has formulated based on the review of the literature (Table 2-2). For this reason, the statements were categorised as *strategic*, *financial* or *operational*. The *strategic* section focuses on subjects such as control on the project, knowledge management and client cooperation and satisfaction, while the *financial* concerns mainly the identification of possible economic benefits brought by the TPL company, and the *operational* section aims to identify practical advantages and disadvantages that TPL has caused to the on-site work. Finally, at the end of each section, the respondent was given the possibility to add any additional comment related to the subject of said section.

3.4 Ethical conduct

To ensure the integrity of this work's ethical conduct, a few precautions were taken. Firstly, interviewees voluntarily participated to the interview. Prior to the interview they were briefly informed regarding the aim of the research and the scope of the interview. Moreover, the interviewee was informed that his or her anonymity was guaranteed at all times throughout the work, so that the interviewee could freely respond to any given question. Additionally, consent to record the interview was requested from the interviewee. The registration was later transcribed in order to avoid possible misunderstandings, and to ensure that no information was missed. Regarding the survey, the tool used to conduct the survey (Google Forms) ensure total anonymity to the respondents, meaning that not even the author can exactly identify the source of a given answer. The only question in the survey that was directly related to the person regarded what role the respondent had, but never which specific project it concerned.

3.5 Trustworthiness

Trustworthiness consist of four criteria – *credibility*, *transferability*, *dependability* and *confirmability* (Bryman, 2012). The following text of this paragraph has been written in relation to Bryman's definition of said criteria. To cherish the *credibility*, indicating how trustworthy the results are, the conducted interviews were recorded, allowing the authors to prevent misunderstandings by having the possibility to replay the recordings. A "do not know" option was also added to each statement of the questionnaire, as to not force a respondent to an opinion that does not match their perception. Large focus has been aimed at being detailed, both in terms of gathering and analysing data, striving for a high level of *transferability*, making the outcome transferable to future research. In addition to interview recordings, correspondence related to the selection of questionnaire respondents is also available, yielding a high level of *dependability*. Finally, both authors have been engaged equally throughout the thesis process, minimising the risk for personal values in the written material. Additionally, as both a TPL company and customers of TPL companies has been enquired, both sides of the coin have been considered. Thus, *confirmability* has been attained in the thesis.

4 Empirical findings

This chapter presents the results of the empirical research. The chapter is divided into two sections. In the first section, Company A, their practices, experiences and views on TPL in relation to the construction industry, is presented as emerged in the interviews and correspondence. The second section displays the results of the conducted survey.

4.1 Company A

During the consultation of Company A, many subjects were touched upon. In the following, this information is divided into "*Company A and their practices"* and *"Company A's view on Third-Party Logistics and the construction industry"*.

4.1.1 Company A and their practices

According to Company A, their role in projects they are hired for, is to design a system for the inflow of materials that can guarantee successful outcome of the project, meaning delivering the project on time, within budget and with the right quality. To create an efficient system, Company A does ideally participate in the project already in the design phase, in order to avoid possible logistics issues related to the architecture of the building or the organisation of the construction site. However, it is not uncommon for Company A to be hired in later stages of the project, to restructure the logistics system in an effort for optimisation. Moreover, Company A often operates in large projects, where many different contractors, working close to each other, need to be coordinated.

Even though every project is different and needs a specific solution, Company A has principals they follow in their practices:

- *Plan for an increased inflow of materials*. Through a detail-planned and well-timed delivery system, it is possible to achieve a constant and smooth stream of incoming material to the building site. Said system is capable of handling a large number of deliveries. In this way, *Just-in-Time* deliveries can be achieved, reducing or eliminating waiting time related to the deliveries for the construction workers.
- *Increase control over the deliveries*. According to Company A, the traditional construction company has control over just 5% of their goods reception. On the contrary, Company A aims to control at least 80% of the incoming goods. To reach this goal, Company A implements a *checkpoint area* close by the entrance of the construction site, where goods are received at a precisely scheduled time, and inspected before proceeding to enter the site. Moreover, Company A utilise an *online booking system* for the deliveries, in which the different contractors are asked to specify the exact time for the delivery and other related details, such as the delivery size and the responsible person for the reception of the goods. With this tool, Company A can gather the necessary information to prepare a detail schedule.
- *Reduce unnecessary space on site.* Despite what could be expected, according to Company A, TPL companies should aim to reduce or eliminate excessive space on the construction site. The reasoning behind this statement is that an excess of space gives the contractor the chance for unnecessary on-site storage and chaotic organisation of the space, which should be avoided. Moreover, working in project with space constraint, pushes the contractor to work in a more diligent and regulated way, following schedules and plans and allocating to the project the most skilled workers. Finally, if space is limited on the construction site, contractors are forced to not accumulate waste on site.

In this regard, Company A try to optimise the outflow of waste. In Sweden, according to company A, some waste can be carried only by personal with specific education, so it is not possible for the delivery trucks to also carry out all the waste. However, Company A plan the logistics to sort the waste in different categories. The waste that can be carried out without garbage trucks are then removed directly.

- *Change the mindset on site.* Company A stressed how even a well-thought out plan will fail if not everyone, from the delivery truck driver to the construction worker, recognise the importance of logistics and take responsibility for the work they carry out. For this reason, one of the most important and often overlooked tasks for a TPL company is to make clear for everyone on site the importance of good logistics. To achieve this, according to Company A, the only possible way is to show to everyone on site the advantages they themselves can gain by performing the work as planned.

The current online delivery booking system, that Company A has been using for the last ten years across roughly 60 projects, is, in their view, simple but efficient. The system was developed specifically for logistics of construction project differently from the majority of the others system used in the industry, which, as stated by Company A, are tools for general logistics. According to Company A, their delivery booking system has proven particularly efficient, especially in larger projects, where it has been necessary to administer deliveries to several different contractors, operating in the same area at the same time.

The data collected on the online delivery booking system are used to detail plan the delivery schedule. However, said data is also used after the project is delivered to evaluate the performance of the plan, i.e. to understand what went well and what did not go according to plan. This pool of knowledge is, according to Company A, their true strength and is the foundation of their expertise in developing logistics plans to manage complex project, such as hospitals and shopping malls, or projects where cooperation among different construction companies is required.

4.1.2 Company A's view on Third-Party Logistics and the construction industry

Company A truly believes that, through good logistics planning, it is possible to get better quality, as well as cheaper and faster projects. Company A claims that, in the projects they are involved in, they can normally save about 25% compared to the competitors or the initial budget. In some case this figure can even reach 60-70%. However, as far as Company A is concerned, "logistics in construction is not existing" and as a discipline it "gets no respect", meaning that it is unfortunately too common that project owners and contractors often underestimate the importance of logistics. Company A argues that, in truth, construction companies would rather continue using the same traditional practices and work as they are used to, despite projects being often delayed or over budget. Furthermore, it is Company A's opinion that the recent interest of contractors for logistics is driven only by a mare temporary trend and not by a deep understanding of the importance of this subject. Company A states that most construction companies, because of this trend, often acquire a logistics system and apply to the construction project themselves. However, Company A continues, if the application of those systems is not combined with expertise on the field, based on knowledge and experience, no system can have successful outcome, because there is no system that can simply be directly applied to any project and have good results.

Another logistical solution that is implemented in construction projects, to facilitate the work with LPS and pulling of the materials to the construction site, is the implementation of a CCC that is managed by TPL, or by the construction company themselves. However, it is Company A's opinion that this kind of solution is detrimental to the goal of achieving a successful project. Company A argues that CCC is a "placebo solution" that promote approximate and sometimes careless planning, because construction materials appear to be always available. However, they continue, in reality this solution does not decrease the inventory levels but simply moves the inventory away from the construction site, and, additionally, this kind of inaccurate planning decrease the speed of the project development. The reason why the development of the project slows down is that, when allowing the construction company to pull materials on demand to the construction site, the pressure on the construction company to keep up with the planned schedule decreases. Moreover, Company A states that, if deliveries are not well-coordinated and planned in detail, chaos and inefficiency will spread to the rest of the operations on site too. Finally, Company A goes as far as stating that CCC only causes extra handling and repackaging of the construction material, and that they are only economically profitable for transportation companies, or those who manage the CCC, but never for construction company.

4.2 Survey results

The survey was handed to approximately 400 people working in the industry with different roles. Out of the contacted people, only approximately 20% responded, and 50% of those answered that either the company they work for choose to manage their logistics solution in-house, or they were unfamiliar to the concept of TPL. The survey gathered, in total, 40 answers from people that have been involved in projects as site-manager, purchaser, foreman, production-manager etc. Out of those answers, 16 regarded projects where a TPL company was hired to manage the material handling on site, 13 regarded projects where the hired TPL company manages logistics and deliveries through a CCC and 11 answers regarded projects where a TPL company using DBS was hired. The respondent has also got to mention what type of construction project the answers relate to, and there has been, among others, apartments, offices, hospitals, hotels, universities and schools. Spreadsheets containing all the detailed answers are given in Appendix H, Appendix I and Appendix J. Additionally, the comments of the respondents are shown in Appendix K. In the following section, the results are presented in terms of the three identified factors.

4.2.1. Strategic results

Regarding the strategic benefits of TPL solutions, it is possible to see from the results of the survey, shown in Appendix B, that the most prominent benefit reported by the respondents is that hiring TPL firms allow construction companies to focus on their core activities. This benefit was reported, to some degree, in more than 80% of the answers for all the different types of TPL implementation. Additionally, in 25% of the cases regarding *TPL managing OSH* and *TPL using CCC*, respondents fully agreed that TPL firms offer these benefits. The other most common benefit, that can be seen in Appendix B, is the possibility to utilise external logistical competence. This benefit is reported to some degree in 50%, 75% and 85% of the cases for *TPL managing OSH*, *TPL using DBS* and *TPL using CCC* respectively. Finally, in all three implementation types, more than 50% of the respondents report how, to different degrees, hiring a TPL firm offers the opportunity to reshape the whole supply chain in a beneficial way. This benefit was the most polarising among the respondents with experiences in project where *TPL using CCC* had been hired. Almost 25% of those respondents fully agree that *TPL using CCC* offers this possibility (the highest score among the different TPL solutions). At the same time,

25% of the respondents to some extent disagree to this statement (also the highest percentage among the different TPL solutions).
The remaining three benefits were not as common among respondents. Only between 25% and 50% of the respondents, in all three cases, agreed that, at least to some degree, hiring TPL firms helped to increase customer satisfaction, or offered an opportunity for a more efficient learning of logistics capabilities. Finally, the least common benefit with TPL, as can be seen in Appendix B, is the increased flexibility for changes in the products, needs and requests. The most critical about this subject is the respondents that had experience with *TPL managing OSH* and *TPL using DBS*. Only 20% and 10%, respectively, agreed that hiring a TPL firm brought this advantage. On the contrary, 40% of the respondents for *TPL managing OSH* and 60% of the respondents for *TPL using DBS*, to some extent, disagreed with this statement.

Looking at the strategic drawbacks, presented in Appendix C, for all three types of TPL implementation, more than 50% of the respondents, to some extent, disagreed with the four proposed disadvantages. Regarding *TPL managing OSH*, no respondent agreed that implementing such solution decreased contact with clients and responsiveness to their requests, while less than 10% partially agreed that *TPL managing OSH* was met with lack of consent from own employees or it reduced in-house capabilities. The most common drawback for this TPL solution was where the respondent had experienced a decrease in control. However, this was reported, to some degree, only in the 25% of the answers. Concerning *TPL using CCC*, decrease of control and lack of acceptance from own employees were experienced to some extent by approximately 25% of the respondent, while the remaining two issues were reported in less than 10% and 0% respectively. Finally, in the case of *TPL using DBS*, the most common issue experienced by the respondent was a decrease of in-house capability, experienced to some degree by 25% of the respondent. Decrease of control and lack of consent by own employees were experienced in 20% of the cases, while reduced contact with the client was reported only in 10% of the answers.

4.2.2. Financial results

The first thing to consider when looking at the financial benefits results, presented in Appendix D, is a high portion of "do not know" answers. In the survey's section that considers the financial aspects, this answer was at times used by 20-30% of the respondents and peaked at 40%. This is due to the fact that respondents could have a role in the project that do not have insight on the economy. Moreover, there is only one case where at least 50% of the respondents, to some extent, agreed to the proposed financial benefits of TPL.

Starting from cost reduction, due to the implementation of a TPL solution, it is possible to see that 40% of the respondents agree to at least some extent that such cost reduction is experienced with *TPL managing OSH*, as seen in Appendix D. In this case, 40% neither agree nor disagree. Less favourable, concerning this benefit, are the answers regarding *TPL using DBS*. In this case, only 20% of the respondents agreed, to some extent, that the TPL solution brought cost reduction, while more than 35%, fully or partially, disagreed. 45% of the respondents of *TPL using DBS* neither agree nor disagree to this statement. Finally, the subject of cost reduction was another polarising theme among the respondents for *TPL using CCC*. In this case, 50% of the respondent agreed, fully or partially, that this logistical solution brought cost reductions, while 30% disagreed fully or partially. The remaining 20% neither agreed nor disagreed.

In regard to the possibility to benefit from economy of scale and scope, the percentage of respondents that answered to this particular question was, as previously stated, relatively low.

However, the respondents who answered this question were generally positive with similar figures in all three types of TPL implementation.

When considering the possibility to reduce capital tied-up to assets, all three TPL solutions scored low among the respondents, with *TPL using DBS* scoring the lowest. In this case, no respondent agreed that hiring *TPL using DBS* brought this benefit, 20% neither agreed nor disagreed, 10% partially disagreed and 35% fully disagreed. In the case of *TPL using CCC*, only 5% fully agreed that this benefit was experienced, 50% neither agreed nor disagreed and 25% fully disagreed. Finally, regarding *TPL managing OSH*, 45% disagreed partially or totally with the statement, while 5% agreed only partially.

Considering the financial drawbacks proposed to the respondents, as shown in Appendix E, it is possible to see that 70% of the respondents for *TPL managing OSH* did not experience a decrease in knowledge regarding internal logistics costs. Regarding the same aspect, this figure drops to less than 50% for *TPL using CCC* and just about 25% for *TPL using DBS.* On the contrary, more than 35% and 25% of the respondents for *TPL using DBS* and *TPL using CCC,* respectively, agreed, to at least some extent, that knowledge of internal logistics cost decreased as a consequence of hiring a TPL firm. Less concerning was the cost structure implementation, with 15-25% of the respondents for TPL agreeing only partially that they experienced an unreasonable cost structure, while 40-50% disagreed, fully or partially, in all three cases.

4.2.3 Operative results

The survey responses regarding the operative benefits of hiring a TPL firm are shown in Appendix F. Regarding *TPL managing OSH*, it is possible to notice that the most common operative benefits, as highlighted by the respondents, are the increase of operation efficiency on site, the reduction of inventory levels and the increase in delivery efficiency. In those regards, 90%, 80% and 70% of the respondents, respectively, agreed partially or fully that the benefit was experienced. The remaining proposed benefits were, however, less common, with only 25-30% of the respondents agreeing, at least partially, that such benefits were achieved. Regarding *TPL using CCC* it can be seen how, for each of the proposed operative benefit, at least 50% of the respondent agreed partially of fully that said benefit was experienced. Additionally, more than 75% of the respondents for *TPL using CCC* agreed, to different degrees, that improvement in inventory levels, delivery efficiency and on-site operations efficiency was experienced due to hiring the TPL firm. The only remarks made by the *TPL using CCC* respondents regarded the reduction of order cycle times. Regarding this proposed benefit, 30% of those respondents disagreed, partially or fully, that said benefit was experienced. Shorter order cycle time was not common among respondents of *TPL using DBS*. Of those respondents, 35% disagreed, at least partially, that this benefit occurred, while only 20% agreed, partially of fully. More common were instead the remaining proposed benefits, among the respondents of *TPL using DBS*. 90% of those experienced, to some degree, more efficient delivery services, while approximately 75% agreed, partially or fully, that the TPL provided a well-performing IT system and helped reduce the inventory levels. Finally, 60% of the respondents for *TPL using DBS* agreed, at least partially, that the lead-time decreased, and the efficiency of the on-site operations increased.

Regarding the proposed operative drawbacks, seen in Appendix G, it is possible to notice how 25% of the respondents for *TPL managing OSH* experienced, to different degrees, issues regarding the TPL firm's competencies and their ability to deal with special requests and products. 10% of those respondents also experienced inadequate service performances that caused disturbances in the inflow of materials. However, no respondent experienced any issue

regarding the ability of *TPL managing OSH* to cope with unexpected emergency occurrences. Approximately 50% of the respondents for *TPL managing OSH* disagreed, partially or fully, that any of the proposed drawbacks did occur.

The results of the survey show that, at least, 50% of the respondents for *TPL using CCC* disagreed, at least partially, with all four of the proposed drawbacks, peaking at 80% disagreeing respondents when considering the TPL provider's insufficient competencies (no respondent agreed to this drawback). The remaining operative drawbacks scored between 25% and 15% of partially or fully agreeing respondents.

Finally, the results shown for *TPL using DBS* are less favourable. In this case, at least 25% of the respondents agree, partially or fully, with the proposed drawbacks. More specifically, 25% of the respondents agreed, partially or fully, that the TPL firm failed to cope with unexpected occurrences and displayed insufficient competencies and employee capability (65% and 75%, respectively, disagreed partially or fully); 35% experienced, to different extent, inadequate service performance and disturbances of the material inflow (50% agreed partially); and lastly, 55% of the respondents for *TPL using DBS* felt that the TPL firm failed to deal with special requirement and products, while just 35% disagreed partially or fully.

4.2.4 Survey comments

A few of the survey responses has been complemented with comments. For OSH, the general conception is that hiring TPL allow the contractor to focus on their core activities by freeing up time for the workers to produce, rather than having to handle materials. It can also allow the contractor to have less workers on site. However, this only goes for the workers, as the management team still has to be engaged, and involve the TPL firm, in the planning of deliveries. By scheduling the deliveries outside work hours, the TPL team on site can carry in the material without having to collide with the workers, and the workers can get started right away the morning after. It is also expressed that it is easy to get an overview of the costs, as they are reported separately. On the downside, there is a case where the contractor experienced that the TPL firm took over and tore up an already working system, which lead to more material on site. Additionally, the TPL provider's IT system could not handle different floors, leading to material being distributed to the wrong places.

As for CCC, it is expressed that it, to some extent, is a cost driver, but that it mainly is difficult to calculate the deal. The respondent has also experienced that own employees, usually in charge of transport, become indolent and request the same salary, despite having part of their responsibility outsourced.

Finally, regarding DBS, one respondent expresses it to be economically feasible, while another states that it is expensive, yet effective. However, it is also expressed that the TPL provider did not take caution in their operation, damaging the building in the process.

5 Analysis and Discussion

A main reason towards implementing TPL is cost reduction. Sobotka & Czarnigowska (2005), Lindén & Josephson (2013) and van Laarhoven, et al., (2000) all mention cost reduction as a result of implementing TPL. van Laarhoven, et al., (2000) even state that cost reduction is the strongest and most common reason to adopt a TPL solution, and that cost reduction below expectation is one of the most common reasons for terminated relationships with TPL firms. However, when looking at the survey results, only 40% mention reduced costs as part of their experiences. In the case of *TPL using DBS*, that figure go as low as 18%. In fact, out of all respondents, 25% say that their costs have increased. Yet, out of those having experienced increased costs, 80% mention that they have experienced more efficient delivery service, and 60% also state having experienced an increased operations efficiency. Those two factors can likely contribute to time savings, which in turn translates to a reduction of man hours, thus also cost savings. What construction companies might not take into account is that these factors, most likely, will have a positive impact on the project economy along the process. Additionally, the possibility for the contractor to focus on their core competencies, as highlighted by 85% of the respondents, could help them gain a competitive advantage in the market, since resources would only be assigned to value adding activities. Additionally, reducing inventory levels on site, which has been experienced by 80% of the respondents, could help minimise material wastes, thus gaining cost savings. Finally, one possible cause of such harsh judgment by the customers, regarding the cost saving benefits, may be found in the high importance of this aspect for the customers, who are thus more prone to criticism in case of underwhelming outcome.

Moreover, different types of TPL implementation have shown to have their distinct strengths and weaknesses. In order to compare and analyse the three forms of TPL implementation, a score from 0 to 100 has been given to each answer, where 0 is the score for the least favourable answer (fully disagree for a benefit or fully agree for a drawback) and vice versa. The scores have then been compiled, both in terms of TPL solution type and issue category, using the average of all responses. The compiled scores are seen below, in Table 5-1, Table 5-2 and Table 5-3.

Table 5-1 – Strategic overall results.

Strategic overall	
OSH	69
CCC	70
DBS	67

Table 5-2 – Financial overall results.

Financial overall	
OSH	65
CCC	59
DBS	52

Table 5-3 – Operative overall results.

Operative overall	
OSH	64
CCC	70
DBS	62

5.1 OSH overall score

As can be seen in Table 5-1, Table 5-2 and Table 5-3, according to the customers of TPL firms, the overall strength of *TPL managing OSH* is the financial aspects. OSH is experienced by the TPL customers as the most cost effective TPL solution. However, this does not necessarily mean that this implementation is, in fact, the most financially beneficial, but rather that it is the one that is most commonly experienced in this way. The reason for this result could be found in the fact that this implementation requires the least initial investment from the construction company, and often does not need any costly restructure of management. Additionally, the cost structure of this form of TPL implementation was shown to be clearly defined, so that

construction companies do not experience a decreased knowledge of the logistics costs. This could help the hiring company keep track of where the finances are spent, thus increasing the perceived value of the offered service.

Hiring TPL firms to manage OSH also show great results in terms of allowing the contractor to focus on core competencies, as well as improved operations efficiency, which sounds reasonable as the craftsmen have more time to focus on producing. However, hiring TPL companies to only handle the delivered material could have a positive impact on the efficiency of the deliveries as well. Scheduling well-utilised deliveries after operating hours can likely reduce the amount of deliveries during operating hours, easing the pressure on the logistics function. It also makes way for a more efficient construction process, as not only can the skilled craftsmen focus on their area of expertise, but the material can also be transported to various on-site locations without having to interfere with the craftsmen. Finally, *TPL managing OSH* could probably be the most appropriate solution for less complicated projects, where the construction company does not need, or want, to invest for a complete redesign of the supply chain structure, but rather only a help to decrease the work-load caused by non-value adding activities.

5.2 CCC overall score

As seen in Table 5-1, Table 5-2 and Table 5-3, *TPL using CCC* scored well in terms of strategic and operative issues, but the financial issues seem to be its substantial weakness. 85% of the respondents expressed that, by implementing a CCC solution, they could focus on their core competencies. At the same time, 25% expresses having experienced a loss of control. Although the TPL is responsible for managing the deliveries, it is essential that they communicate with the contractor and are transparent in the operations, in order for the contractor not to experience loss of control.

Lundesjö (2015) stated that reducing the amount of material stored on site is a central point in using a CCC solution. As 80% of the respondents state that they have experienced decreased inventory levels, with the remaining experiencing no considerable difference, the survey results confirm this statement. However, the contractor, and potential sub-contractors, also has an important responsibility in planning the demand a few days ahead, in a *Last Planner* fashion, so that the right amount of material can be delivered (Lundesjö, 2015). Furthermore, 77% has experienced more efficient operations. A reason for this could be the buffer function that the CCC provides. As the material arrives to the CCC prior to site, there is a possibility to correct damaged goods and/or incorrect deliveries before needing the material on site, thus avoiding interruptions in the construction process.

As for the financial aspects, keeping in mind that cost reduction is one of the strongest arguments towards implementing a TPL solution, 30% of the respondents have actually experienced increased costs using a CCC solution. In addition, only 10% of the respondents, having used CCC, has experienced a reduction in tied-up capital. As Robbins (2015) states, CCC is the most expensive and resource-intensive way to handle the flow of materials. Thus, it is important to make sure that you really need this solution, and that you can fully utilise its entire set of virtues. For dense urban areas, CCC might very well be the most favourable option, but if the construction site is outside of town and easily accessible, implementing a CCC solution might just end up redundant. Regarding the low reduction of tied-up capital, Sullivan, et al., (2010) mention that, to maintain efficient use of the storage area that a CCC provides,

materials should ideally be stored no more than 14 days. If not, CCC's risk ending up just another long-time storage, holding plenty of capital tied-up in materials.

5.3 DBS overall score

As it can be seen in Table 5-1, Table 5-2 and Table 5-3, *TPL using DBS* did score the lowest score in each and every category. The main reasons for those scores, as highlighted by the TPL customers, are the underwhelming financial performances of this logistical solution, with cost savings experienced only rarely by the customers and a perceived loss of control over the logistics costs, the low score in flexibility and the poor ability to deal with special requests and emergency occurrences. A possible reason for those scores could be that, as stated by Company A in chapter 4.1.1, to function properly, a JIT system for deliveries requires precise planning and discipline from each employee to stick to the agreed schedule. This solution could leave too small room for last minute changes in the schedule to cope with the unpredictable nature of the work on the construction site. A possible solution could be to integrate huddle meetings and LPS practices to the process, as discussed in chapter 2.5, and allow some buffer time-slots in the DBS. Additionally, Company A's financial claims in chapter 4.1.2 prove that, if mindfully implemented, DBS can also grant considerable cost and time savings. In other words, the need for accurate planning and execution in the implementation of a DBS requires high levels of experience and effort but, if implemented properly, could allow for considerable gains.

Additionally, it is important to remark, as presented in chapter 2.10, environmental factors, such as the location of the building site and the traffic in the area, as they can play an important role in the success of a delivery system that aims to increase the total number of deliveries (Robbins, 2015). To reduce the influence of those factors, it could be beneficial to establish a Construction Logistics Plan (Transport for London, 2017), as shown in chapter 2.2, prior to the implementation of the DBS solution.

Another aspect to consider regarding *TPL using DBS* is that the required effort for its implementation may not be suitable for smaller projects. However, as stated by Company A, this solution finds its strength and best application in larger projects, when the DBS can be used to manage deliveries to many contractors working simultaneously in the same area. This coordinative aspect could easily be overlooked by the single contractor, but could prove particularly beneficial for the whole building project to avoid conflicts and promote cooperation among different actors operating on the same site.

6 Conclusion

This chapter summarises the finding of this work in order to respond to the research questions that are the matter of this research. Furthermore, some suggestions for future research are proposed.

Which are the main forms of TPL implementation in the construction industry today?

This study indicates that there are three main forms of implementation of Third-Party Logistics solutions in the Swedish construction industry today. The first and most simple implementation consists in the TPL firm managing only the On-Site Handling of the construction materials. Scheduling of the deliveries is not administered by the TPL firm in this kind of solution. The remaining two implementations delegate the planning of the construction material delivery system to the TPL firm. This structure can be shaped in two way: with the adoption of a Construction Consolidation Centre, which aims to reduce the number of delivery vehicles going to the construction site by optimising the vehicle utilisation, or by adopting a Delivery Booking System, which is suitable to manage a high number of deliveries, establishing a smooth and constant inflow of materials to the construction site and promoting coordination among different actors on site. Both of the two latter solutions can also be combined with On-Site Handling for ulterior efficiency.

What are the strengths and weaknesses with each form of TPL implementation, as experienced by the clients?

According to the clients, the main common strength among Third-Party Logistics solutions in the construction industry are that they all allow construction companies to focus on their core capabilities, focusing their efforts and resources on value adding activities in order to gain a competitive advantage on the competitors on the market. But they all have their individual strengths and weaknesses as well.

On-Site Handling finds its strength in the miniscule, yet effective, implementation. It does not require a large initial investment to implement, but it saves the contractor's workers a lot of time, in terms of material handling. By scheduling deliveries outside of operating hours, the TPL firm can transport the material to specific on-site locations without potentially obstructing craftsmen, and the craftsmen can simply get to work first thing in the morning the day after. Furthermore, having deliveries outside of operating hours can also lower the number of deliveries during operating hours, easing the pressure on the logistics function. The negative part about On-Site Handling is that it is a somewhat moderate solution. It is effective, but to have the potential to achieve greater rewards, a more extensive implementation is needed. But, at the same time, a more extensive implementation also entails greater risks.

The Construction Consolidation Centre solution has its strength in dense urban areas, that can easily become congested, as it reduces the number of delivery vehicles having to go to site. Furthermore, it holds great potential to reduce the inventory on site, as well as the capital tied-up in assets. On the downside, inefficient utilisation of the Construction Consolidation Centre could entail increased costs, which is the exact opposite of the main reason towards implementing a Third-Party Logistics solution.

TPL firms using a Delivery Booking System exhibit a strength in providing an efficient delivery service, which is able to manage a large number of deliveries to the construction site. Moreover,

this solution offers the possibility to coordinate deliveries for different contractors operating in the same building site. On the contrary, detail planning could become a weakness, reducing the chance for a flexible work schedule that can easily cope with product changes, special requirements or unforeseen events that are common in an unpredictable environment, such as the construction industry.

How can TPL be implemented in the most effective and beneficial way, and how can the identified weaknesses be overcome?

For On-Site Handling of materials, scheduling deliveries within or outside of operating hours can play a big role in its efficiency, so in order for the solution to reach its full potential, it is recommended to schedule deliveries outside of operating hours. This way, the materials can be brought in on the construction site without risking of disturbing the construction process.

The Construction Consolidation Centre solution is most preferable in urban areas, where the surrounding traffic is sensitive to congestion. As it is the most expensive solution, it is essential that its features can be properly utilised, or the solution will just end up costing the project money. All contractors in the project should use the *Last Planner* system to plan their demand in materials for a few upcoming days, to keep the on-site inventory at an adequate level. Efficient planning in a longer perspective prevent the Construction Consolidation Centre from becoming a long-time storage, containing plenty of tied-up capital. Proper communication with the Third-Party Logistics provider help prevent experiencing a loss of control.

In order to implement a Third-Party Logistics solution using a Delivery Booking System, it is important, in the first place, to engage each and every participant to the project in this solution. Everyone, from the workers to the management, need to understand the importance of respecting the planned schedule, and that divergence from this will inevitably have consequences on the whole project, causing delays and, ultimately, waste of resources. Thus, using the *Last Planner* system to prepare the upcoming days' deliveries can help the logistics team cope with special requests and needs from the contractor. Additionally, even though this system is based on tight schedules and detail planning, it would be good practice to leave some buffer time-slot to cope with unexpected occurrences that can happen on the construction site, thus gaining the flexibility that many clients have highlighted to lack in this kind of solution.

Finally, it is important to underline how, after this study has been conducted, no construction logistics solution has emerged as the most advantageous one. In other words, it is possible to conclude that there is today no such thing as "the absolute best construction logistics solution", but rather "the best logistics solution for the given project". For this reason, the best way to overcome the shortcomings of each form of Third-Party Logistics implementation is to be conscious of these weaknesses, and choose the solution that best fit the project: Third-Party Logistics managing On-Site Handling for smaller and simpler projects; Third-Party Logistics using Construction Consolidation Centres for larger projects in areas with space constraints, such as city centres; and finally, Third-Party Logistics using Delivery Booking System for projects that require coordination among different contractors and large numbers of deliveries daily.

6.1 Future research

In the future, it could be interesting for researchers to extend the quantitative research of this thesis to a wider population, which was unfortunately not possible to achieve in this work due to a low response rate and the time limitations of this work. Moreover, disposing of a larger population could allow further research to investigate deeper in the obtained data to try to identify if there are any correlation between the given answer, the role and the project type of the respondent. Finally, additional researches could try to compare the performances of the Third-Party Logistics solutions to those developed and implemented in-house by the construction companies.

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Appendix

Appendix A: Survey questions

Below is the survey that has been used to gather customer experiences. In order to economise on the space, the answer alternatives have been removed for question 2-25, but they are identical to those of question 1.

*Obligatorisk

Bakgrundsinformation om projektet

Hur var leveranserna till byggarbetsplatsen organiserade av TPL? *

- [ ] Via samlastningscentral (construction consolidation centre)
- [ ] Tidsbokningssystem med mottagningskontroll (checkpoint)
- [ ] TPL skötte enbart inbärning av material, inte organisering av leveranser
- [ ] Annat/vet ej

Vilken typ av projekt gäller det? (Sjukhus, lägenhetshus, etc) *

Vad var din roll i projektet? *

Strategiskt

1. Ni upplevde en ökad möjlighet att fokusera på er kärnkompetens. *

- ○ Stämmer helt
- ○ Stämmer delvis
- ○ Varken eller
- ○ Stämmer delvis inte
- ○ Stämmer inte alls
- ○ Vet ej

2. Ni upplevde en förlust av kontroll. *

3. Ni upplevde en möjlighet att dra nytta av logistikexpertis från TPL. *

4. Ni upplevde ett missat tillfälle att skaffa erfarenhet och egen kompetens. *

5. Ni upplevde en ökad flexibilitet kring ändringar i produkt, behov och krav. *

6. Ni upplevde en minskad kundkontakt och hörsamhet för kundens behov, krav och önskemål. *

7. Ni upplevde en ökad kundnöjdhet. *

8. Ni upplevde motsättning från egna anställda. *

9. Ni upplevde en möjlighet att ändra och strukturera om i er supply chain. *

10. Ni upplevde ett ökat och mer effektivt lärande. *

Eventuella övriga positiva/negativa strategiska aspekter ni upplevde:

Finansiellt

11. Ni upplevde sänkta kostnader (arbete och underhåll av utrustning inkluderat). *

12. Ni upplevde en orealistisk kostnadsstruktur. *

13. Ni upplevde mindre uppbundet kapital. *

14. Ni upplevde minskad kunskap om era egna interna logistikkostnader. *

15. Ni upplevde att ni kunde nyttja skalfördelar. *

Eventuella övriga positiva/negativa finansiella aspekter ni upplevde:

Operativt

16. Ni upplevde minskade lagernivåer på byggarbetsplatsen. *

17. Ni upplevde bristfällig expertis och/eller arbetskompetens från TPL. *

18. Ni upplevde en förbättrad ledtid på ordrar. *

19. Ni upplevde en oförmåga från TPL att hantera särskilda behov och produkter. *

20. Ni upplevde en minskning i tid mellan placering av ordrar. *

21. Ni upplevde en oförmåga från TPL att hantera akuta omständigheter. *

22. Ni upplevde effektivare leveranser. *

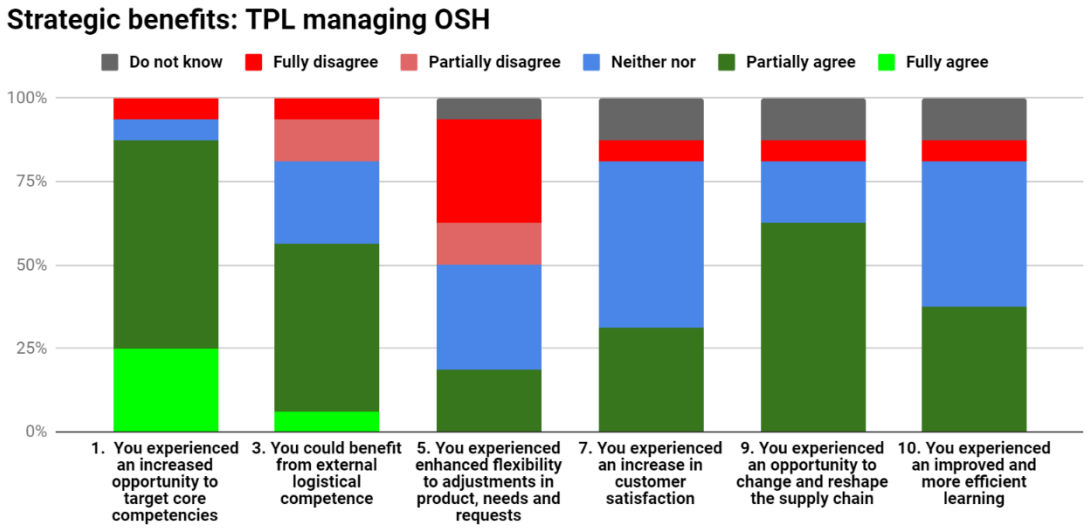
23. Ni upplevde bristfällig serviceprestanda och störningar i det inkommande flödet. *

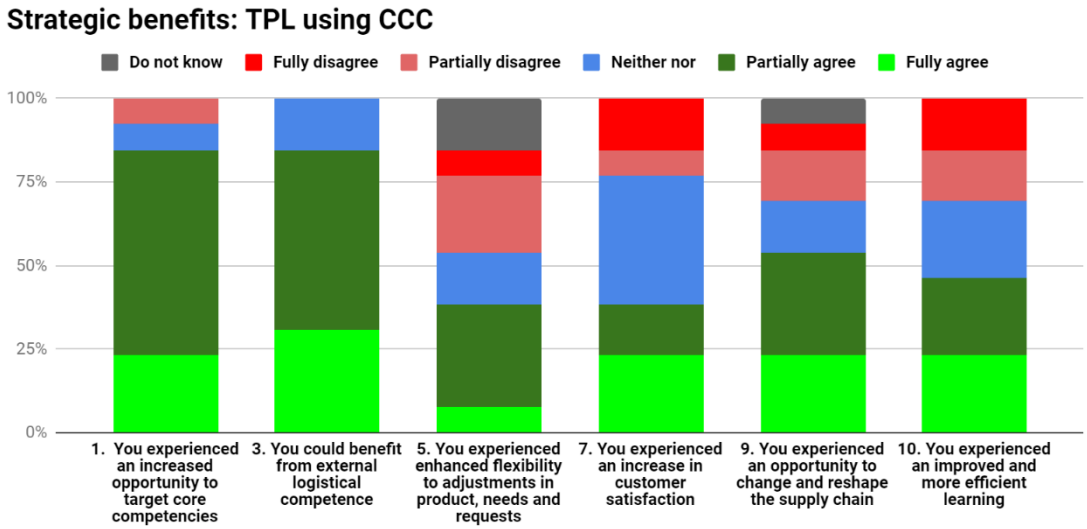
24. Ni upplevde en effektivare byggprocess. *

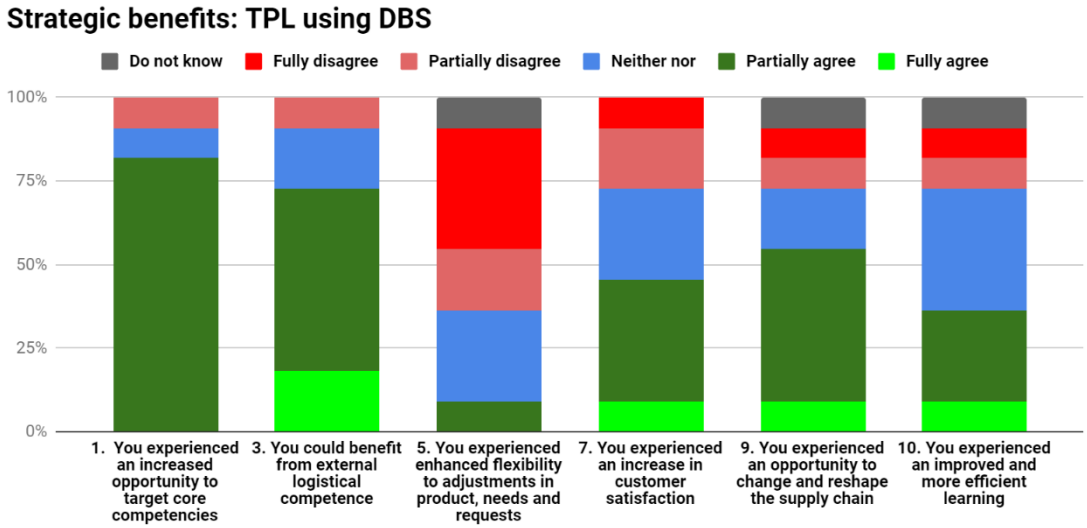
25. Ni upplevde att TPL:s IT-system fungerade effektivt. *

Eventuella övriga positiva/negativa operativa aspekter ni upplevde:

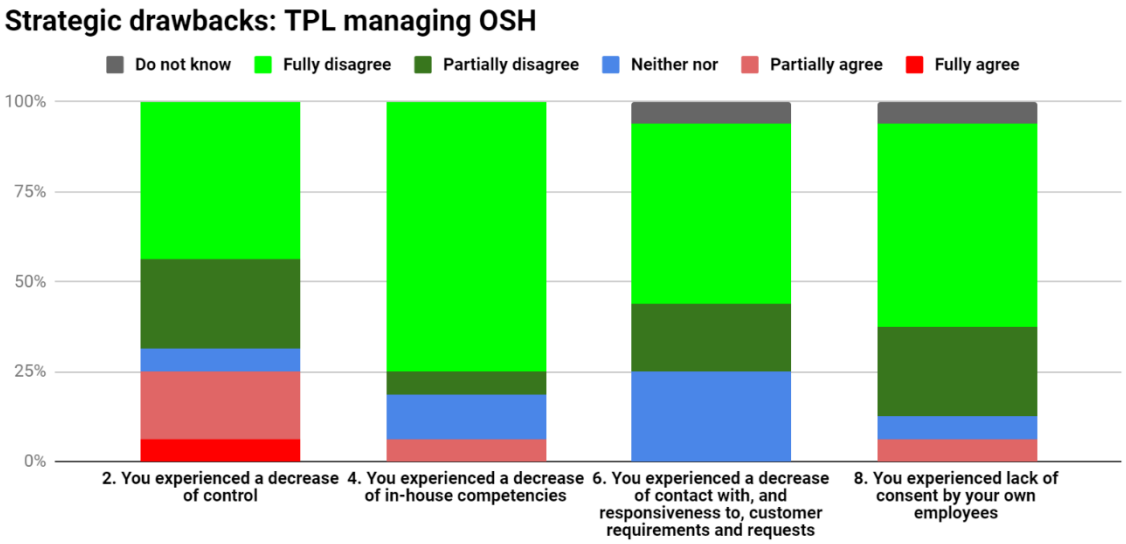
Appendix B: Survey results – Strategic benefits

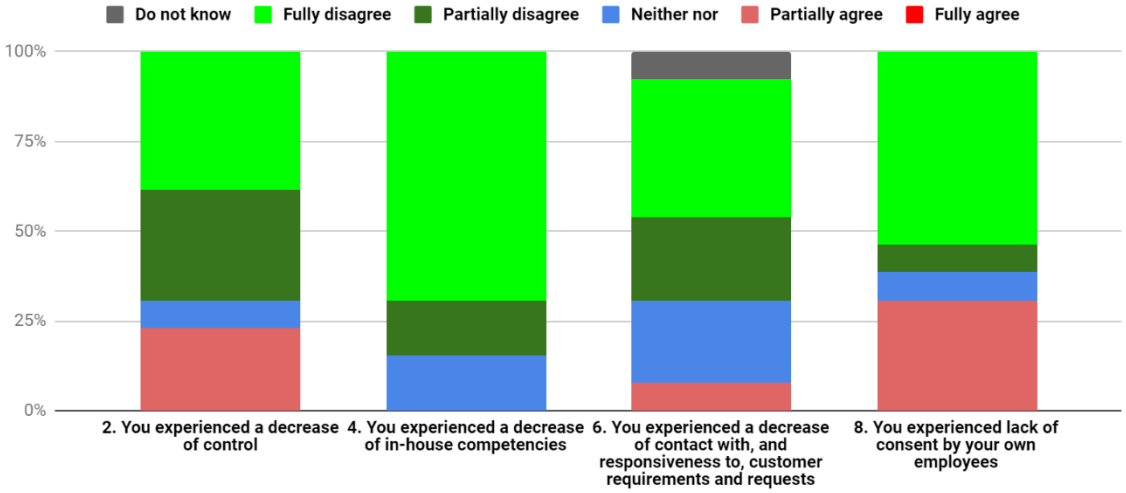


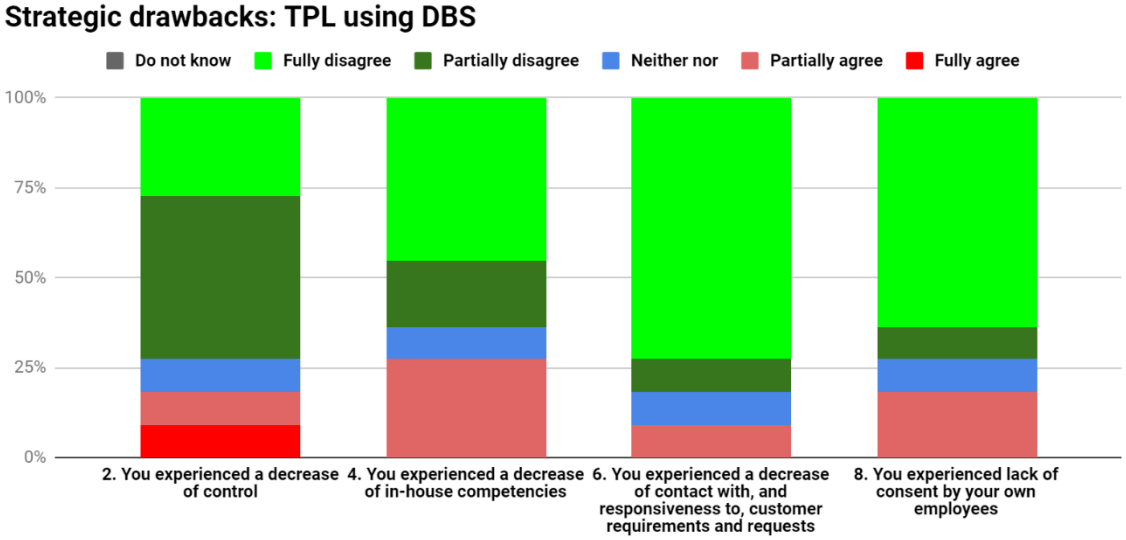




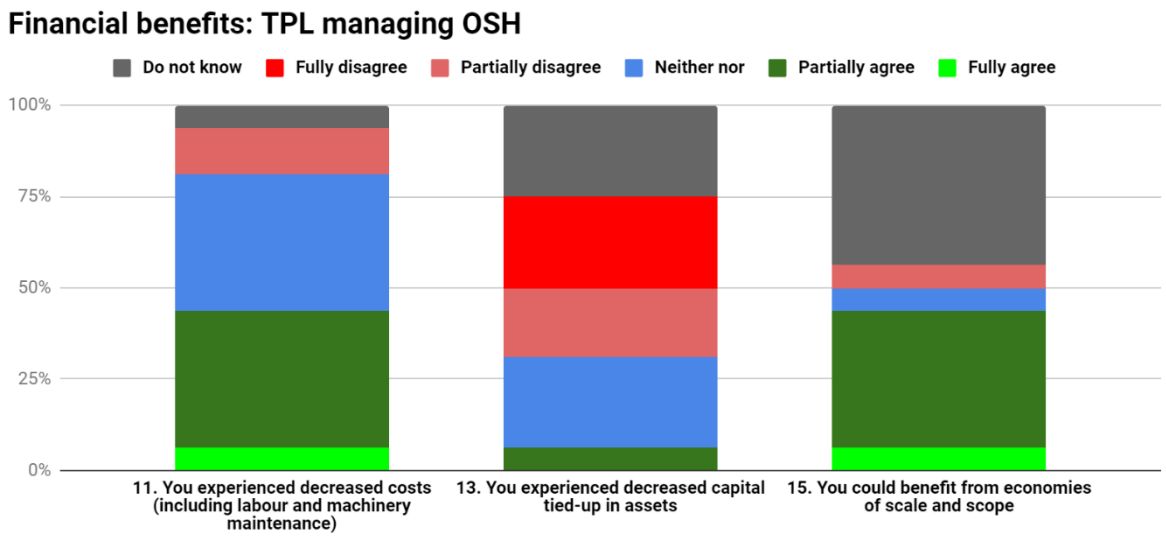
Appendix C: Survey results – Strategic drawbacks

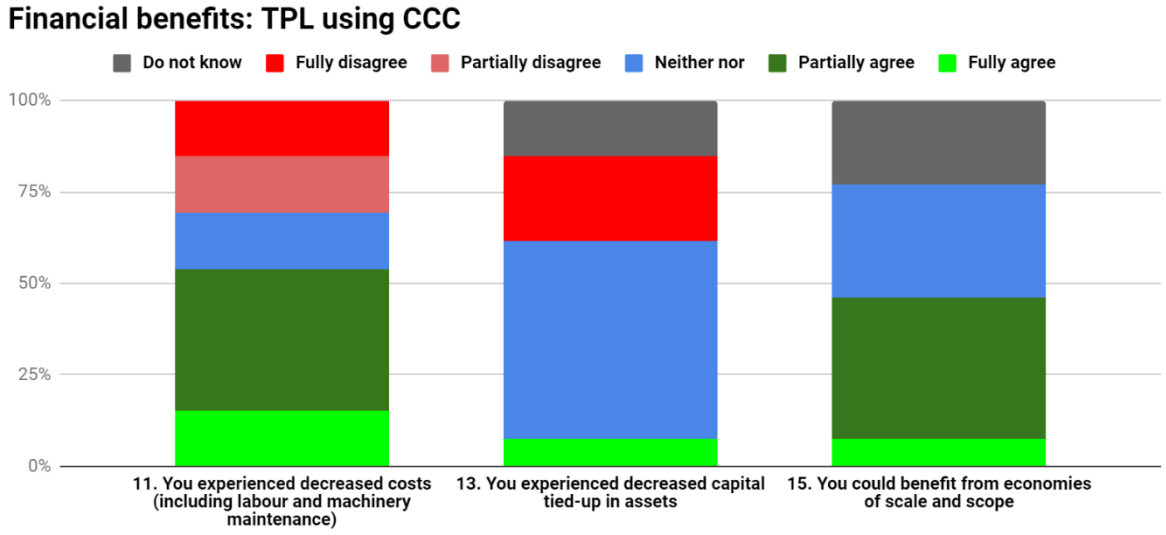


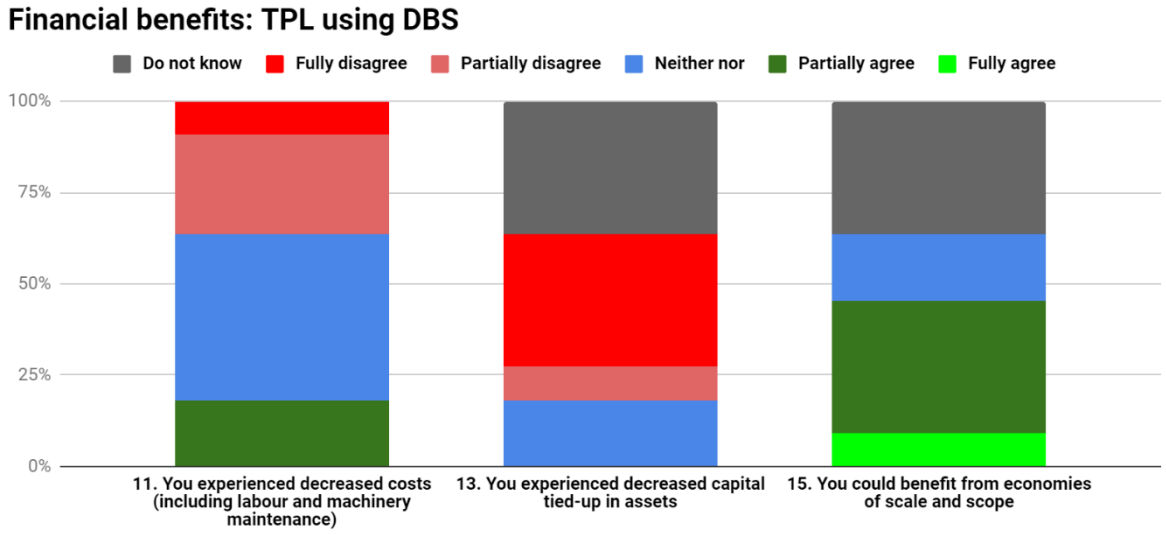




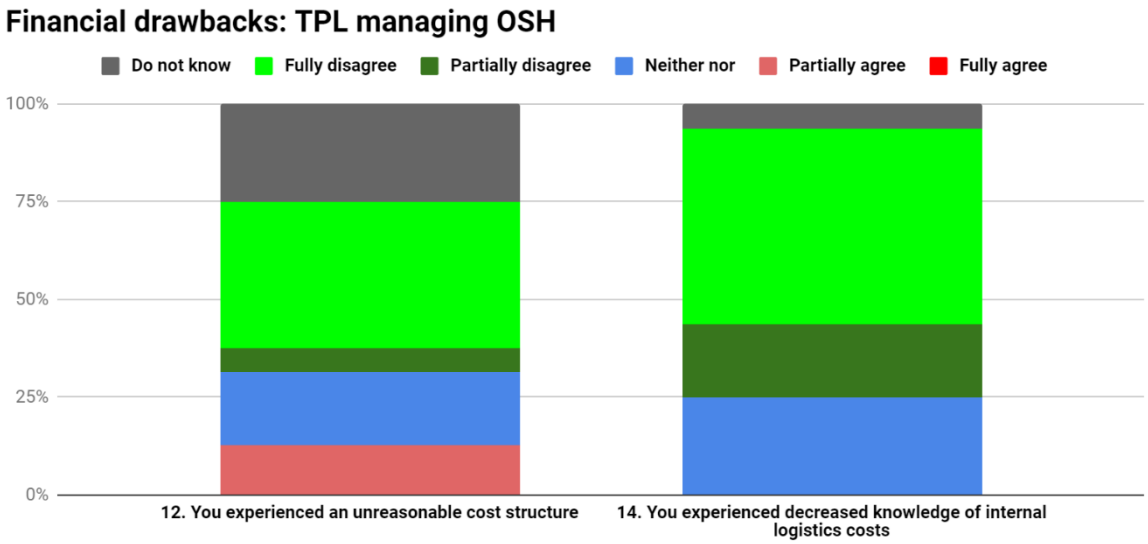
Appendix D: Survey results – Financial benefits

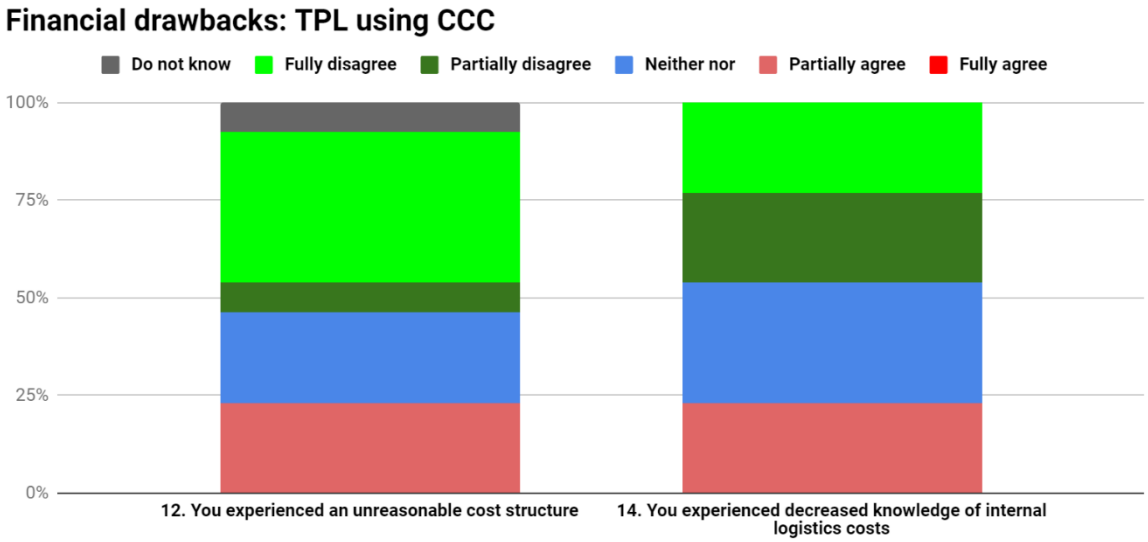


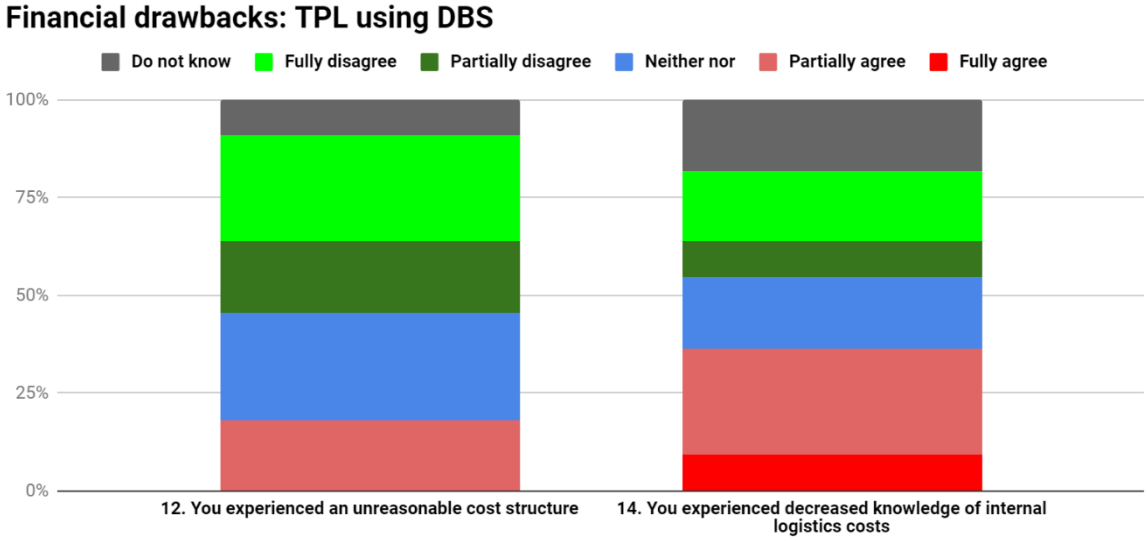




Appendix E: Survey results – Financial drawbacks

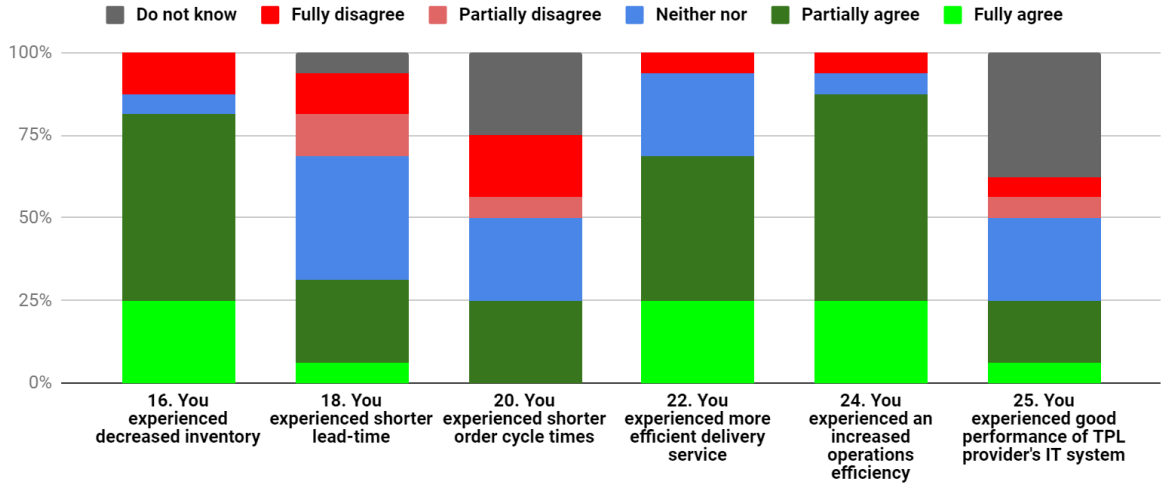




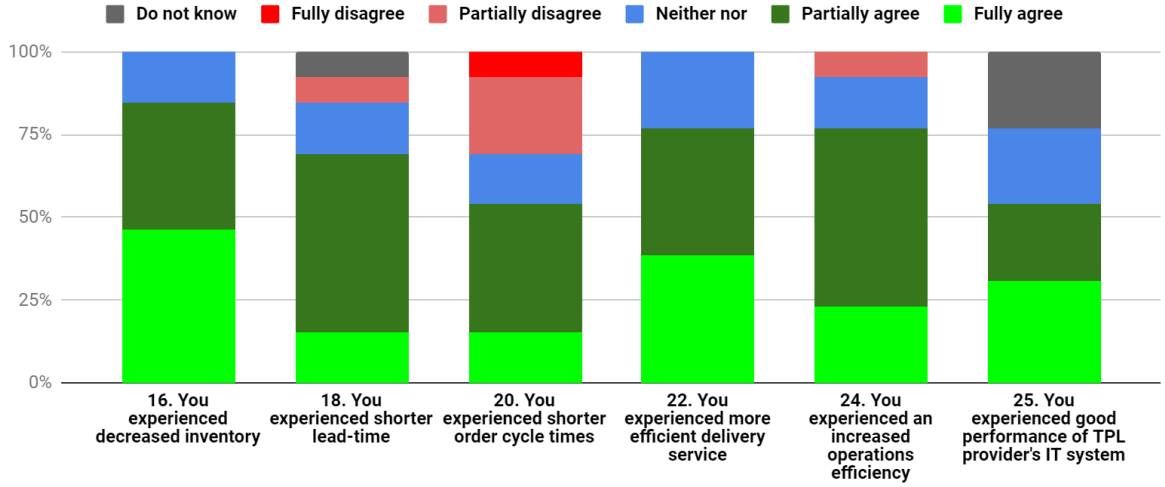


Appendix F: Survey results – Operative benefits

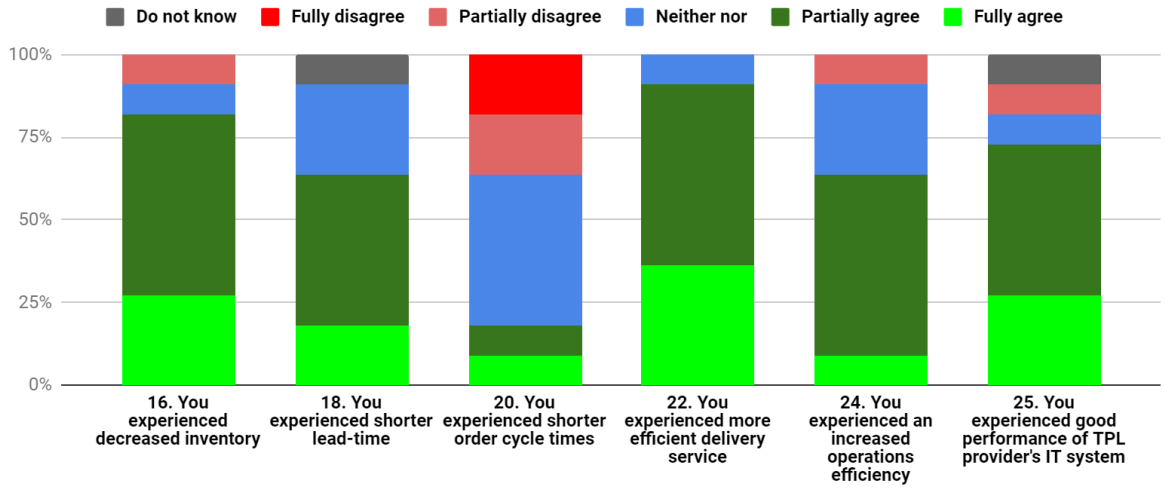
Operative benefits: TPL managing OSH



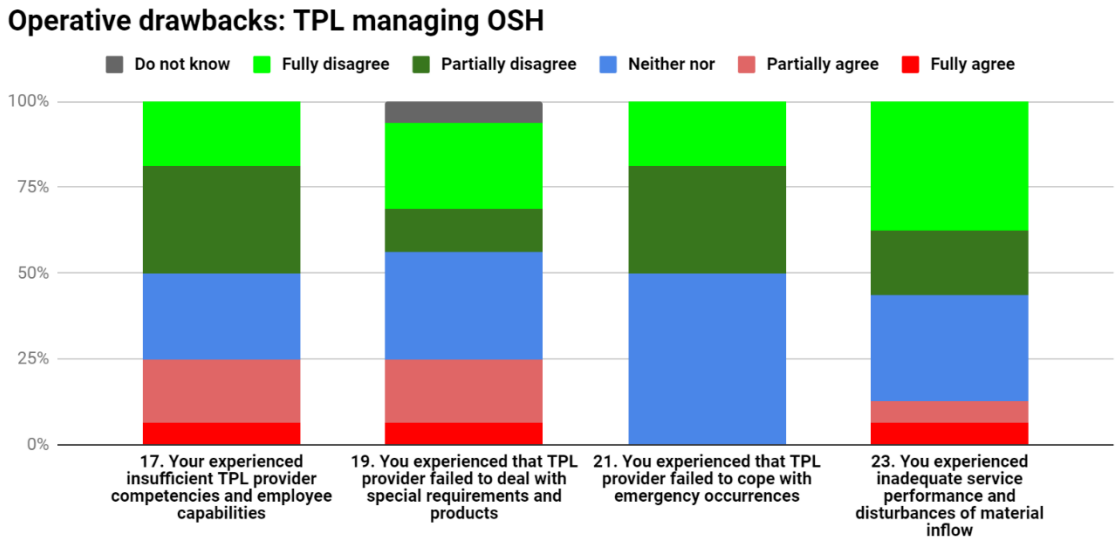
Operative benefits: TPL using CCC

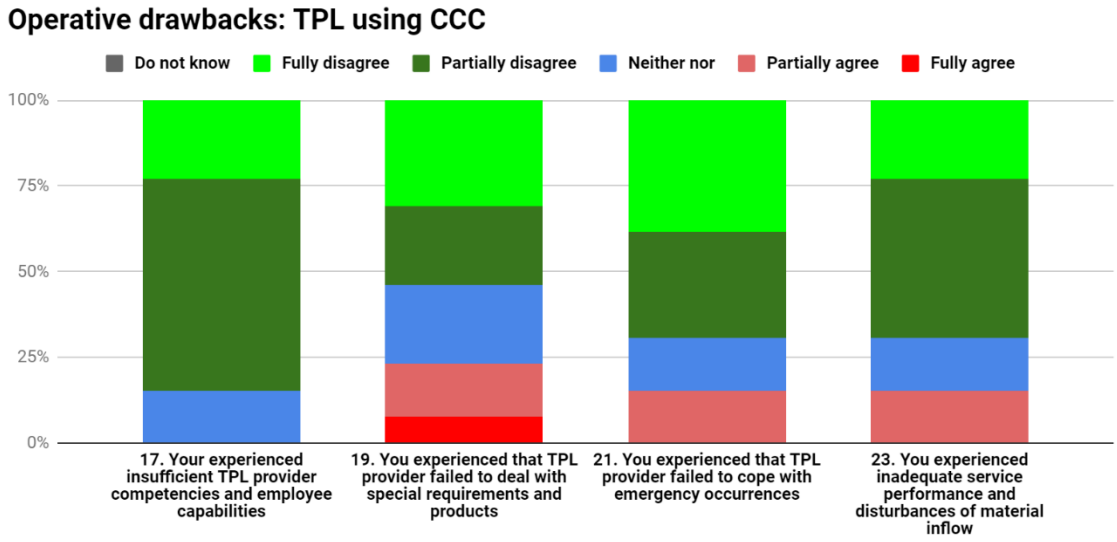


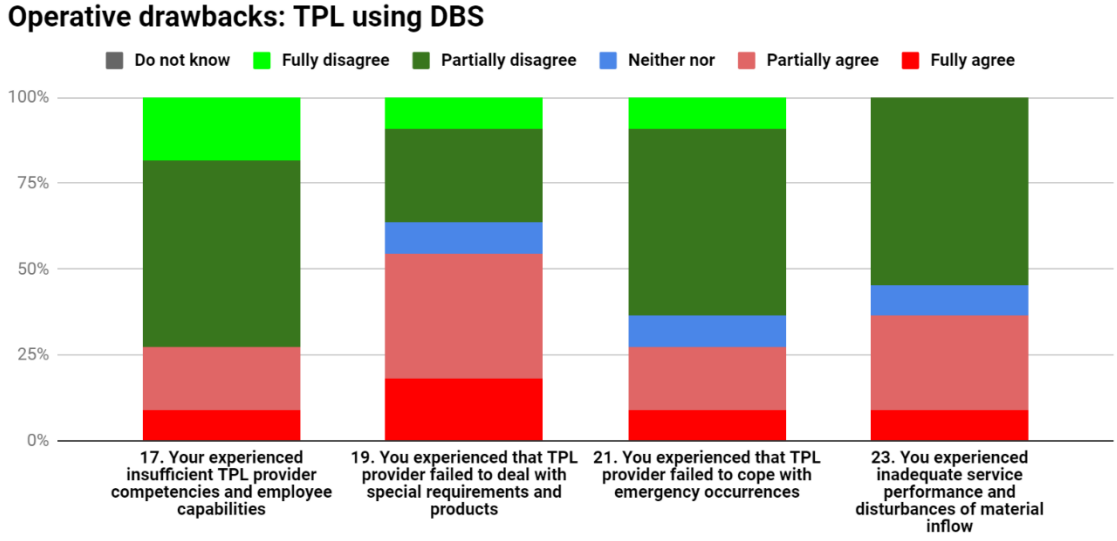
Operative benefits: TPL using DBS



Appendix G: Survey results – Operative drawbacks







Appendix H: Survey answers – Strategic

In this section, the answers to the statements concerning *strategic* aspects of TPL are reported as chosen by each respondent. For this reason, the answers are reported in Swedish, as the survey was performed. Black boxes denote “do not know”.

Strategic benefits for TPL managing OSH, answers:

Project	**Role of the respondent**	**1. Ni upplevde en ökad möjlighet att fokusera på er kärnkompetens.**	**3. Ni upplevde en möjlighet att dra nytta av logistikexperts från TPL.**	**5. Ni upplevde en ökad flexibilitet kring ändringar i produkt, behov och krav.**	**7. Ni upplevde en ökad kundnöjdhet.**	**9. Ni upplevde en möjlighet att ändra och strukturera om i er supply chain.**	**10. Ni upplevde ett ökat och mer effektivt lärande.**
Kommersiellt projekt	Arbetsledare	Stämmer delvis	Stämmer delvis	Stämmer inte alls	Varken eller	Stämmer delvis	Varken eller
Hotell	Logistikansvarig	Stämmer helt	Stämmer delvis	Varken eller	Stämmer delvis	Stämmer delvis	Stämmer delvis
Bostäder och kommersiella fastigheter	Logistikspecialist	Stämmer helt	Varken eller	Stämmer delvis	Stämmer delvis	Stämmer delvis	Stämmer delvis
Lamellhus: bostäder/handel.	Platschef	Stämmer delvis	Varken eller	Stämmer delvis	Varken eller	Stämmer delvis	
Lägenheter	Platschef	Stämmer helt	Stämmer delvis	Stämmer inte alls	Stämmer inte alls	Stämmer delvis	Stämmer delvis
Lägenhetshus	Platschef	Stämmer delvis	Varken eller	Varken eller	Varken eller	Varken eller	Varken eller
Bostäder	Platschef	Stämmer delvis	Stämmer delvis	Stämmer delvis inte		Stämmer delvis	Stämmer delvis
Köpcenter	Blockchef	Stämmer inte alls	Stämmer delvis inte	Stämmer inte alls	Varken eller	Stämmer inte alls	Stämmer inte alls
Lägenhetshus	Platschef	Stämmer delvis	Stämmer inte alls	Stämmer inte alls			
Flerbostadshus	Projektingenjör	Stämmer delvis	Stämmer helt		Varken eller	Varken eller	Varken eller
Bostadsrätter	Arbetsledare	Stämmer helt	Varken eller	Varken eller	Varken eller		Varken eller
Bostäder/lokaler/parkeringshus	Platschef	Stämmer delvis	Stämmer delvis	Varken eller	Varken eller	Stämmer delvis	Varken eller
lägenheter	PC	Stämmer delvis	Stämmer delvis	Stämmer delvis	Stämmer delvis	Stämmer delvis	Varken eller
Bostäder	Projektchef	Stämmer delvis	Stämmer delvis inte	Stämmer delvis inte	Stämmer delvis	Stämmer delvis	Varken eller
Lägenheter	Platschef	Varken eller	Stämmer delvis	Varken eller	Varken eller	Stämmer delvis	Stämmer delvis
Universitet	Inköpare	Stämmer delvis	Stämmer delvis	Stämmer inte alls	Stämmer delvis	Varken eller	Stämmer delvis

Strategic benefits for TPL using CCC, answers:

Project	Role of the respondent	1. Ni upplevde en ökad möjlighet att fokusera på er kärnkompetens.	3. Ni upplevde en möjlighet att dra nytta av logistikexpertis från TPL.	5. Ni upplevde en ökad flexibilitet kring ändringar i produkt, behov och krav.	7. Ni upplevde en ökad kundnöjdhet.	9. Ni upplevde en möjlighet att ändra och strukturera om i er supply chain.	10. Ni upplevde ett ökat och mer effektivt lärande.
Båda	Projektchef	Stämmer helt	Stämmer helt	Stämmer delvis	Varken eller	Stämmer delvis	Stämmer delvis
sjukhus	Arbetsledare	Varken eller	Varken eller	Stämmer delvis	Stämmer inte alls	Varken eller	Stämmer delvis inte
Sjukhus	Platschef	Stämmer delvis	Stämmer delvis	Varken eller	Varken eller	Varken eller	Stämmer inte alls
Sjukhus, Skola, Bostäder	Projektchef	Stämmer helt	Stämmer helt	Stämmer delvis	Stämmer helt	Stämmer helt	Stämmer helt
Lägenhetshus	Projektchef	Stämmer delvis	Stämmer delvis	Stämmer delvis	Stämmer delvis	Stämmer delvis	Stämmer delvis
Kontorsanpassning	Platschef	Stämmer delvis	Stämmer delvis	Varken eller	Varken eller	Stämmer delvis inte	Varken eller
lgh hus	Arbetsledare	Stämmer helt	Stämmer delvis	Stämmer helt	Stämmer helt	Stämmer helt	Stämmer helt
Kommersiellt hus	Inköpare	Stämmer delvis	Stämmer delvis	Stämmer delvis inte	Stämmer delvis	Stämmer delvis inte	Stämmer delvis inte
Kontor och butik	Produktionschef	Stämmer delvis	Stämmer helt	Stämmer delvis inte	Stämmer delvis inte	Stämmer delvis	Stämmer delvis
Sjukhus	Ombud	Stämmer delvis	Stämmer helt		Stämmer helt	Stämmer helt	Stämmer helt
Kontor	Arbetsledare	Stämmer delvis inte	Varken eller	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls
Lägenhetshus	Produktionschef	Stämmer delvis	Stämmer delvis	Stämmer delvis inte	Varken eller	Stämmer delvis	Varken eller
kommersiellt, kontor	produktionschef	Stämmer delvis	Stämmer delvis		Varken eller		Varken eller

Strategic benefits for TPL using DBS, answers:

Project	Role of the respondent	1. Ni upplevde en ökad möjlighet att fokusera på er kärnkompetens.	3. Ni upplevde en möjlighet att dra nytta av logistikexpertis från TPL.	5. Ni upplevde en ökad flexibilitet kring ändringar i produkt, behov och krav.	7. Ni upplevde en ökad kundnöjdhet.	9. Ni upplevde en möjlighet att ändra och strukturera om i er supply chain.	10. Ni upplevde ett ökat och mer effektivt lärande.
Lägenheter	Inköpare	Stämmer delvis	Stämmer delvis	Varken eller	Stämmer delvis	Stämmer delvis	Stämmer delvis
Universitet	Platschef	Stämmer delvis	Stämmer delvis	Stämmer delvis	Varken eller	Stämmer delvis	Varken eller
Utbildningslokaler	Platschef	Varken eller	Stämmer delvis inte	Varken eller	Stämmer delvis	Varken eller	
Skola	Platschef	Stämmer delvis	Stämmer delvis	Varken eller	Stämmer delvis		Varken eller
Handelscentrum	Blockchef	Stämmer delvis	Stämmer delvis	Stämmer inte alls	Varken eller	Stämmer delvis	Varken eller
köpcenter,kontor, lägenheter	Arbetsledare	Stämmer delvis	Varken eller	Stämmer inte alls	Stämmer delvis inte	Stämmer delvis inte	Stämmer delvis inte
Universitet	Inköpare	Stämmer delvis	Stämmer delvis	Stämmer inte alls	Stämmer delvis	Varken eller	Stämmer delvis
Kontor och butik	Produktionschef	Stämmer delvis	Stämmer helt	Stämmer delvis inte	Stämmer delvis inte	Stämmer delvis	Stämmer delvis
Sjukhus	Ombud	Stämmer delvis	Stämmer helt		Stämmer helt	Stämmer helt	Stämmer helt
Kontor	Arbetsledare	Stämmer delvis inte	Varken eller	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls
Lägenhetshus	Produktionschef	Stämmer delvis	Stämmer delvis	Stämmer delvis inte	Varken eller	Stämmer delvis	Varken eller

Strategic drawbacks for TPL managing OSH, answers:

Project	**Role of the respondent**	**2. Ni upplevde en förlust av kontroll.**	**4. Ni upplevde ett missat tillfälle att skaffa erfarenhet och egen kompetens.**	**6. Ni upplevde en minskad kundkontakt och hörsamhet för kundens behov, krav och önskemål.**	**8. Ni upplevde motsättning från egna anställda.**
Kommersiellt projekt	Arbetsledare	Stämmer delvis inte	Stämmer inte alls	Varken eller	Stämmer inte alls
Hotell	Logistikansvarig	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls
Bostäder och kommersiella fastigheter	Logistikspecialist	Varken eller	Stämmer inte alls	Varken eller	Stämmer delvis inte
Lamellhus: bostäder/handel.	Platschef	Stämmer delvis	Stämmer inte alls	Stämmer delvis inte	Stämmer inte alls
Lägenheter	Platschef	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls
Lägenhetshus	Platschef	Stämmer inte alls	Stämmer inte alls	Varken eller	Stämmer inte alls
Bostäder	Platschef	Stämmer delvis	Varken eller		Stämmer delvis inte
Köpcenter	Blockchef	Stämmer helt	Varken eller	Stämmer delvis inte	Stämmer delvis
Lägenhetshus	Platschef	Stämmer delvis	Stämmer inte alls	Stämmer inte alls	Varken eller
Flerbostadshus	Projektingenjör	Stämmer delvis inte	Stämmer inte alls	Stämmer inte alls	Stämmer delvis inte
Bostadsrätter	Arbetsledare	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls
Bostäder/lokaler/ parkeringshus	Platschef	Stämmer inte alls	Stämmer delvis	Varken eller	Stämmer delvis inte
lägenheter	PC	Stämmer delvis inte	Stämmer inte alls	Stämmer delvis inte	Stämmer inte alls
Bostäder	Projektchef	Stämmer inte alls	Stämmer delvis inte	Stämmer inte alls	Stämmer inte alls
Lägenheter	Platschef	Stämmer delvis inte	Stämmer inte alls	Stämmer inte alls	
Universitet	Inköpare	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls

Strategic drawbacks for TPL using CCC, answers:

Project	Role of the respondent	2. Ni upplevde en förlust av kontroll.	4. Ni upplevde ett missat tillfälle att skaffa erfarenhet och egen kompetens.	6. Ni upplevde en minskad kundkontakt och hörsamhet för kundens behov, krav och önskemål.	8. Ni upplevde motsättning från egna anställda.
Båda	Projektchef	Stämmer delvis	Stämmer delvis inte	Varken eller	Stämmer inte alls
sjukhus	Arbetsledare	Stämmer delvis	Varken eller		Stämmer delvis
Sjukhus	Platschef	Stämmer inte alls	Stämmer inte alls	Varken eller	Stämmer inte alls
Sjukhus, Skola, Bostäder	Projektchef	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls	Stämmer delvis
Lägenhetshus	Projektchef	Stämmer inte alls	Stämmer inte alls	Stämmer delvis inte	Stämmer inte alls
Kontorsanpassning	Platschef	Stämmer delvis inte	Varken eller	Varken eller	Stämmer delvis inte
lgh hus	Arbetsledare	Stämmer delvis inte	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls
Kommersiellt hus	Inköpare	Varken eller	Stämmer inte alls	Stämmer delvis inte	Stämmer delvis
Kontor och butik	Produktionschef	Stämmer inte alls	Stämmer inte alls	Stämmer delvis inte	Stämmer delvis
Sjukhus	Ombud	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls
Kontor	Arbetsledare	Stämmer delvis inte	Stämmer inte alls	Stämmer delvis	Stämmer inte alls
Lägenhetshus	Produktionschef	Stämmer delvis inte	Stämmer inte alls	Stämmer inte alls	Varken eller
kommersiellt, kontor	produktionschef	Stämmer delvis	Stämmer delvis inte	Stämmer inte alls	Stämmer inte alls

Strategic drawbacks for TPL using DBS, answers:

Project	**Role of the respondent**	**2. Ni upplevde en förlust av kontroll.**	**4. Ni upplevde ett missat tillfälle att skaffa erfarenhet och egen kompetens.**	**6. Ni upplevde en minskad kundkontakt och hörsamhet för kundens behov, krav och önskemål.**	**8. Ni upplevde motsättning från egna anställda.**
Lägenheter	Inköpare	Stämmer delvis inte	Stämmer delvis	Stämmer inte alls	Stämmer inte alls
Universitet	Platschef	Stämmer delvis	Stämmer delvis	Stämmer inte alls	Stämmer inte alls
Utbildningslokaler	Platschef	Varken eller	Stämmer delvis inte	Stämmer inte alls	Stämmer delvis inte
Skola	Platschef	Stämmer helt	Varken eller	Varken eller	Stämmer delvis
Handelscentrum	Blockchef	Stämmer delvis inte	Stämmer delvis	Stämmer inte alls	Stämmer inte alls
köpcenter,kontor,lägenheter	Arbetsledare	Stämmer delvis inte	Stämmer delvis inte	Stämmer inte alls	Stämmer inte alls
Universitet	Inköpare	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls
Kontor och butik	Produktionschef	Stämmer inte alls	Stämmer inte alls	Stämmer delvis inte	Stämmer delvis
Sjukhus	Ombud	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls
Kontor	Arbetsledare	Stämmer delvis inte	Stämmer inte alls	Stämmer delvis	Stämmer inte alls
Lägenhetshus	Produktionschef	Stämmer delvis inte	Stämmer inte alls	Stämmer inte alls	Varken eller

Appendix I: Survey answers – Financial

In this section, the answers to the statements concerning *financial* aspects of TPL are reported as chosen by each respondent. For this reason, the answers are reported in Swedish, as the survey was performed. Black boxes denote “do not know”.

Financial benefits for TPL managing OSH, answers:

Project	**Role of the respondent**	**11. Ni upplevde sänkta kostnader (arbete och underhåll av utrustning inkluderat).**	**13. Ni upplevde mindre uppbundet kapital.**	**15. Ni upplevde att ni kunde nyttja skalfördelar.**
Kommersiellt projekt	Arbetsledare	Stämmer delvis	Varken eller	Varken eller
Hotell	Logistikansvarig			
Bostäder och kommersiella fastigheter	Logistikspecialist	Stämmer helt	Varken eller	Stämmer helt
Lamellhus: bostäder/handel.	Platschef	Varken eller	Stämmer delvis inte	
Lägenheter	Platschef	Stämmer delvis	Varken eller	Stämmer delvis
Lägenhetshus	Platschef	Stämmer delvis		
Bostäder	Platschef	Stämmer delvis inte	Stämmer delvis	Stämmer delvis
Köpcenter	Blockchef	Stämmer delvis inte		
Lägenhetshus	Platschef	Stämmer delvis	Stämmer inte alls	
Flerbostadshus	Projektingenjör	Varken eller	Varken eller	Stämmer delvis
Bostadsrätter	Arbetsledare	Stämmer delvis		
Bostäder/lokaler/ parkeringshus	Platschef	Varken eller	Stämmer inte alls	Stämmer delvis
lägenheter	PC	Varken eller	Stämmer delvis inte	Stämmer delvis
Bostäder	Projektchef	Stämmer delvis	Stämmer inte alls	
Lägenheter	Platschef	Varken eller	Stämmer delvis inte	Stämmer delvis inte
Universitet	Inköpare	Varken eller	Stämmer inte alls	Stämmer delvis

Financial benefits for TPL using CCC, answers:

Project	Role of the respondent	11. Ni upplevde sänkta kostnader (arbete och underhåll av utrustning inkluderat).	13. Ni upplevde mindre uppbundet kapital.	15. Ni upplevde att ni kunde nyttja skalfördelar.
Båda	Projektchef	Stämmer delvis	Stämmer helt	Stämmer delvis
sjukhus	Arbetsledare	Stämmer delvis inte	Stämmer inte alls	Stämmer delvis
Sjukhus	Platschef	Stämmer delvis	Varken eller	Varken eller
Sjukhus, Skola, Bostäder	Projektchef	Stämmer helt	Varken eller	Stämmer helt
Lägenhetshus	Projektchef	Stämmer delvis	Varken eller	Stämmer delvis
Kontorsanpassning	Platschef	Stämmer delvis	Varken eller	Varken eller
lgh hus	Arbetsledare	Stämmer helt		
Kommersiellt hus	Inköpare	Stämmer inte alls	Varken eller	Varken eller
Kontor och butik	Produktionschef	Stämmer inte alls	Stämmer inte alls	Stämmer delvis
Sjukhus	Ombud	Stämmer delvis inte	Stämmer inte alls	
Kontor	Arbetsledare	Varken eller		
Lägenhetshus	Produktionschef	Stämmer delvis	Varken eller	Stämmer delvis
kommersiellt, kontor	produktionschef	Varken eller	Varken eller	Varken eller

Financial benefits for TPL using DBS, answers:

Project	Role of the respondent	11. Ni upplevde sänkta kostnader (arbete och underhåll av utrustning inkluderat).	13. Ni upplevde mindre uppbundet kapital.	15. Ni upplevde att ni kunde nyttja skalfördelar.
Lägenheter	Inköpare	Varken eller	Stämmer inte alls	Stämmer helt
Universitet	Platschef	Varken eller	Varken eller	Varken eller
Utbildningslokaler	Platschef	Varken eller		
Skola	Platschef	Stämmer delvis	Stämmer delvis inte	Varken eller
Handelscentrum	Blockchef	Stämmer delvis inte		Stämmer delvis
köpcenter,kontor,lägenheter	Arbetsledare	Stämmer delvis inte		
Universitet	Inköpare	Varken eller	Stämmer inte alls	Stämmer delvis
Kontor och butik	Produktionschef	Stämmer inte alls	Stämmer inte alls	Stämmer delvis
Sjukhus	Ombud	Stämmer delvis inte	Stämmer inte alls	
Kontor	Arbetsledare	Varken eller		
Lägenhetshus	Produktionschef	Stämmer delvis	Varken eller	Stämmer delvis

Financial drawbacks for TPL managing OSH, answers:

Project	**Role of the respondent**	**12. Ni upplevde en orealistisk kostnadsstruktur.**	**14. Ni upplevde minskad kunskap om era egna interna logistikkostnader.**
Kommersiellt projekt	Arbetsledare	Varken eller	Varken eller
Hotell	Logistikansvarig		
Bostäder och kommersiella fastigheter	Logistikspecialist	Stämmer delvis inte	Stämmer delvis inte
Lamellhus: bostäder/handel.	Platschef	Stämmer inte alls	Stämmer inte alls
Lägenheter	Platschef	Stämmer inte alls	Stämmer inte alls
Lägenhetshus	Platschef		Stämmer inte alls
Bostäder	Platschef	Varken eller	Stämmer delvis inte
Köpcenter	Blockchef		Varken eller
Lägenhetshus	Platschef	Stämmer inte alls	Stämmer inte alls
Flerbostadshus	Projektingenjör	Stämmer inte alls	Varken eller
Bostadsrätter	Arbetsledare		Stämmer inte alls
Bostäder/lokaler/parkeringshus	Platschef	Stämmer inte alls	Stämmer inte alls
lägenheter	PC	Varken eller	Stämmer delvis inte
Bostäder	Projektchef	Stämmer delvis	Stämmer inte alls
Lägenheter	Platschef	Stämmer delvis	Varken eller
Universitet	Inköpare	Stämmer inte alls	Stämmer inte alls

Financial drawbacks for TPL using CCC, answers:

Project	Role of the respondent	12. Ni upplevde en orealistisk kostnadsstruktur.	14. Ni upplevde minskad kunskap om era egna interna logistikkostnader.
Båda	Projektchef	Stämmer inte alls	Stämmer delvis inte
sjukhus	Arbetsledare		Varken eller
Sjukhus	Platschef	Varken eller	Varken eller
Sjukhus, Skola, Bostäder	Projektchef	Stämmer inte alls	Stämmer inte alls
Lägenhetshus	Projektchef	Stämmer inte alls	Stämmer delvis inte
Kontorsanpassning	Platschef	Varken eller	Stämmer inte alls
lgh hus	Arbetsledare	Stämmer delvis inte	Varken eller
Kommersiellt hus	Inköpare	Stämmer delvis	Stämmer delvis inte
Kontor och butik	Produktionschef	Stämmer delvis	Stämmer delvis
Sjukhus	Ombud	Stämmer delvis	Stämmer delvis
Kontor	Arbetsledare	Stämmer inte alls	Varken eller
Lägenhetshus	Produktionschef	Stämmer inte alls	Stämmer delvis
kommersiellt, kontor	produktionschef	Varken eller	Stämmer inte alls

Financial drawbacks for TPL using DBS, answers:

Project	Role of the respondent	12. Ni upplevde en orealistisk kostnadsstruktur.	14. Ni upplevde minskad kunskap om era egna interna logistikkostnader.
Lägenheter	Inköpare	Varken eller	Stämmer delvis inte
Universitet	Platschef	Varken eller	Varken eller
Utbildningslokaler	Platschef	Stämmer delvis inte	
Skola	Platschef	Varken eller	Stämmer helt
Handelscentrum	Blockchef		Stämmer inte alls
köpcenter,kontor,lägenheter	Arbetsledare	Stämmer delvis inte	
Universitet	Inköpare	Stämmer inte alls	Stämmer inte alls
Kontor och butik	Produktionschef	Stämmer delvis	Stämmer delvis
Sjukhus	Ombud	Stämmer delvis	Stämmer delvis
Kontor	Arbetsledare	Stämmer inte alls	Varken eller
Lägenhetshus	Produktionschef	Stämmer inte alls	Stämmer delvis

Appendix J: Survey answers – Operative

In this section, the answers to the statements concerning *operative* aspects of TPL are reported as chosen by each respondent. For this reason, the answers are reported in Swedish, as the survey was performed. Black boxes denote “do not know”.

Operative benefits for TPL managing OSH, answers:

Project	**Role of the respondent**	**16. Ni upplevde minskade lagernivåer på byggarbetsplatsen.**	**18. Ni upplevde en förbättrad ledtid på ordrar.**	**20. Ni upplevde en minskning i tid mellan placering av ordrar.**	**22. Ni upplevde effektivare leveranser.**	**24. Ni upplevde en effektivare byggprocess.**	**25. Ni upplevde att TPL:s IT-system fungerade effektivt.**
Kommersiellt projekt	Arbetsledare	Varken eller	Varken eller	Stämmer delvis inte	Stämmer helt	Stämmer delvis	
Hotell	Logistikansvarig	Stämmer delvis	Stämmer delvis		Stämmer delvis	Stämmer helt	Stämmer helt
Bostäder och kommersiella fastigheter	Logistikspecialist	Stämmer helt	Stämmer delvis inte	Stämmer inte alls	Stämmer helt	Stämmer helt	Stämmer delvis inte
Lamellhus: bostäder/handel.	Platschef	Stämmer delvis	Stämmer delvis	Stämmer delvis	Stämmer delvis	Stämmer delvis	Varken eller
Lägenheter	Platschef	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls	Stämmer helt	
Lägenhetshus	Platschef	Stämmer delvis	Stämmer delvis inte	Varken eller	Varken eller	Varken eller	Varken eller
Bostäder	Platschef	Stämmer delvis			Stämmer delvis	Stämmer delvis	
Köpcenter	Blockchef	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls	Varken eller	Stämmer inte alls	Stämmer inte alls
Lägenhetshus	Platschef	Stämmer delvis	Varken eller		Stämmer delvis	Stämmer delvis	
Flerbostadshus	Projektingenjör	Stämmer delvis	Varken eller	Varken eller	Varken eller	Stämmer delvis	
Bostadsrätter	Arbetsledare	Stämmer helt	Stämmer helt		Stämmer helt	Stämmer helt	
Bostäder/lokaler/parkeringshus	Platschef	Stämmer helt	Varken eller	Stämmer delvis	Varken eller	Stämmer delvis	Varken eller
lägenheter	PC	Stämmer delvis	Varken eller	Stämmer delvis	Stämmer delvis	Stämmer delvis	Stämmer delvis
Bostäder	Projektchef	Stämmer helt	Varken eller	Varken eller	Stämmer helt	Stämmer delvis	Varken eller
Lägenheter	Platschef	Stämmer delvis	Stämmer delvis	Stämmer delvis	Stämmer delvis	Stämmer delvis	Stämmer delvis
Universitet	Inköpare	Stämmer delvis	Stämmer delvis	Varken eller	Stämmer delvis	Stämmer delvis	Stämmer delvis

Operative benefits for TPL using CCC, answers:

Project	Role of the respondent	16. Ni upplevde minskade lagernivåer på byggarbetsplatsen.	18. Ni upplevde en förbättrad ledtid på ordrar.	20. Ni upplevde en minskning i tid mellan placering av ordrar.	22. Ni upplevde effektivare leveranser.	24. Ni upplevde en effektivare byggprocess.	25. Ni upplevde att TPL:s IT-system fungerade effektivt.
Båda	Projektchef	Stämmer helt	Stämmer helt	Stämmer delvis	Stämmer helt	Stämmer delvis	Varken eller
sjukhus	Arbetsledare	Stämmer delvis	Stämmer delvis	Stämmer delvis	Varken eller	Varken eller	Varken eller
Sjukhus	Platschef	Varken eller	Varken eller	Varken eller	Stämmer delvis	Stämmer delvis	
Sjukhus, Skola, Bostäder	Projektchef	Stämmer helt	Stämmer delvis inte	Stämmer delvis	Stämmer helt	Stämmer helt	
Lägenhetshus	Projektchef	Stämmer delvis	Stämmer delvis	Stämmer delvis	Stämmer delvis	Stämmer delvis	Stämmer delvis
Kontorsanpassning	Platschef	Stämmer delvis	Varken eller	Stämmer delvis	Varken eller	Stämmer delvis	Stämmer delvis
lgh hus	Arbetsledare	Stämmer helt	Stämmer helt	Stämmer helt	Stämmer helt	Stämmer helt	Stämmer helt
Kommersiellt hus	Inköpare	Stämmer helt	Stämmer delvis	Stämmer delvis inte	Stämmer helt	Stämmer helt	Stämmer helt
Kontor och butik	Produktionschef	Stämmer delvis	Stämmer delvis	Stämmer delvis inte	Stämmer delvis	Varken eller	Varken eller
Sjukhus	Ombud	Stämmer helt	Stämmer delvis	Stämmer inte alls	Stämmer delvis	Stämmer delvis	Stämmer helt
Kontor	Arbetsledare	Varken eller	Stämmer delvis	Stämmer helt	Varken eller	Stämmer delvis inte	
Lägenhetshus	Produktionschef	Stämmer delvis	Stämmer delvis	Stämmer delvis inte	Stämmer helt	Stämmer delvis	Stämmer delvis
kommersiellt, kontor	produktionschef	Stämmer helt		Varken eller	Stämmer delvis	Stämmer delvis	Stämmer helt

Operative benefits for TPL using DBS, answers:

Project	Role of the respondent	16. Ni upplevde minskade lagernivåer på byggarbetsplatsen.	18. Ni upplevde en förbättrad ledtid på ordrar.	20. Ni upplevde en minskning i tid mellan placering av ordrar.	22. Ni upplevde effektivare leveranser.	24. Ni upplevde en effektivare byggprocess.	25. Ni upplevde att TPL:s IT-system fungerade effektivt.
Lägenheter	Inköpare	Stämmer delvis	Varken eller	Varken eller	Stämmer helt	Stämmer delvis	Stämmer helt
Universitet	Platschef	Stämmer delvis	Varken eller	Varken eller	Stämmer delvis	Varken eller	Stämmer delvis inte
Utbildningslokaler	Platschef	Stämmer delvis inte	Varken eller	Varken eller	Stämmer delvis	Varken eller	Stämmer delvis
Skola	Platschef	Stämmer helt	Stämmer helt	Stämmer delvis	Stämmer helt	Stämmer delvis	Stämmer helt
Handelscentrum	Blockchef	Stämmer helt	Stämmer helt	Varken eller	Stämmer helt	Stämmer helt	Stämmer delvis
köpcenter,kontor,lägenheter	Arbetsledare	Stämmer delvis		Stämmer inte alls	Stämmer delvis	Stämmer delvis	Stämmer delvis
Universitet	Inköpare	Stämmer delvis	Stämmer delvis	Varken eller	Stämmer delvis	Stämmer delvis	Stämmer delvis
Kontor och butik	Produktionschef	Stämmer delvis	Stämmer delvis	Stämmer delvis inte	Stämmer delvis	Varken eller	Varken eller
Sjukhus	Ombud	Stämmer helt	Stämmer delvis	Stämmer inte alls	Stämmer delvis	Stämmer delvis	Stämmer helt
Kontor	Arbetsledare	Varken eller	Stämmer delvis	Stämmer helt	Varken eller	Stämmer delvis inte	
Lägenhetshus	Produktionschef	Stämmer delvis	Stämmer delvis	Stämmer delvis inte	Stämmer helt	Stämmer delvis	Stämmer delvis

Operative drawbacks for TPL managing OSH, answers:

Project	**Role of the respondent**	**17. Ni upplevde bristfällig expertis och/eller arbetskompetens från TPL.**	**19. Ni upplevde en oförmåga från TPL att hantera särskilda behov och produkter.**	**21. Ni upplevde en oförmåga från TPL att hantera akuta omständigheter.**	**23. Ni upplevde bristfällig serviceprestanda och störningar i det inkommande flödet.**
Kommersiellt projekt	Arbetsledare	Stämmer inte alls	Stämmer inte alls	Stämmer delvis inte	Stämmer inte alls
Hotell	Logistikansvarig	Stämmer delvis inte	Stämmer inte alls	Stämmer inte alls	Stämmer delvis inte
Bostäder och kommersiella fastigheter	Logistikspecialist	Stämmer delvis	Stämmer delvis	Stämmer delvis inte	Stämmer inte alls
Lamellhus: bostäder/handel.	Platschef	Stämmer delvis inte	Stämmer delvis inte	Varken eller	Varken eller
Lägenheter	Platschef	Stämmer inte alls	Stämmer inte alls	Varken eller	Stämmer inte alls
Lägenhetshus	Platschef	Varken eller	Varken eller	Varken eller	Varken eller
Bostäder	Platschef	Stämmer inte alls		Stämmer delvis inte	Stämmer inte alls
Köpcenter	Blockchef	Stämmer helt	Stämmer helt	Varken eller	Stämmer helt
Lägenhetshus	Platschef	Stämmer delvis	Varken eller	Varken eller	Varken eller
Flerbostadshus	Projektingenjör	Stämmer delvis inte	Varken eller	Varken eller	Varken eller
Bostadsrätter	Arbetsledare	Stämmer delvis inte	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls
Bostäder/lokaler/parkeringshus	Platschef	Varken eller	Varken eller	Varken eller	Stämmer delvis inte
lägenheter	PC	Varken eller	Stämmer delvis	Stämmer delvis inte	Varken eller
Bostäder	Projektchef	Varken eller	Stämmer delvis inte	Stämmer delvis inte	Stämmer inte alls
Lägenheter	Platschef	Stämmer delvis	Stämmer delvis	Varken eller	Stämmer delvis
Universitet	Inköpare	Stämmer delvis inte	Varken eller	Stämmer inte alls	Stämmer delvis inte

Operative drawbacks for TPL using CCC, answers:

Project	Role of the respondent	17. Ni upplevde bristfällig expertis och/eller arbetskompetens från TPL.	19. Ni upplevde en oförmåga från TPL att hantera särskilda behov och produkter.	21. Ni upplevde en oförmåga från TPL att hantera akuta omständigheter.	23. Ni upplevde bristfällig serviceprestanda och störningar i det inkommande flödet.
Båda	Projektchef	Stämmer delvis inte	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls
sjukhus	Arbetsledare	Varken eller	Stämmer delvis	Varken eller	Stämmer delvis
Sjukhus	Platschef	Varken eller	Varken eller	Varken eller	Varken eller
Sjukhus, Skola, Bostäder	Projektchef	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls
Lägenhetshus	Projektchef	Stämmer delvis inte	Stämmer delvis inte	Stämmer delvis	Stämmer delvis inte
Kontorsanpassning	Platschef	Stämmer delvis inte	Stämmer delvis inte	Stämmer delvis inte	Varken eller
lgh hus	Arbetsledare	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls	Stämmer inte alls
Kommersiellt hus	Inköpare	Stämmer delvis inte	Varken eller	Stämmer inte alls	Stämmer delvis inte
Kontor och butik	Produktionschef	Stämmer delvis inte	Stämmer delvis inte	Stämmer delvis inte	Stämmer delvis inte
Sjukhus	Ombud	Stämmer inte alls	Stämmer delvis	Stämmer delvis	Stämmer delvis inte
Kontor	Arbetsledare	Stämmer delvis inte	Stämmer helt	Stämmer delvis inte	Stämmer delvis
Lägenhetshus	Produktionschef	Stämmer delvis inte	Stämmer inte alls	Stämmer delvis inte	Stämmer delvis inte
kommersiellt, kontor	produktionschef	Stämmer delvis inte	Varken eller	Stämmer inte alls	Stämmer delvis inte

Operative drawbacks for TPL using DBS, answers:

Project	Role of the respondent	17. Ni upplevde bristfällig expertis och/eller arbetskompetens från TPL.	19. Ni upplevde en oförmåga från TPL att hantera särskilda behov och produkter.	21. Ni upplevde en oförmåga från TPL att hantera akuta omständigheter.	23. Ni upplevde bristfällig serviceprestanda och störningar i det inkommande flödet.
Lägenheter	Inköpare	Stämmer delvis	Stämmer delvis	Stämmer delvis	Varken eller
Universitet	Platschef	Stämmer delvis	Stämmer delvis	Varken eller	Stämmer delvis
Utbildningslokaler	Platschef	Stämmer delvis inte	Stämmer delvis inte	Stämmer delvis inte	Stämmer delvis inte
Skola	Platschef	Stämmer helt	Stämmer helt	Stämmer helt	Stämmer helt
Handelscentrum	Blockchef	Stämmer inte alls	Stämmer delvis	Stämmer delvis inte	Stämmer delvis
köpcenter,kontor,lägenheter	Arbetsledare	Stämmer delvis inte	Stämmer delvis inte	Stämmer delvis inte	Stämmer delvis inte
Universitet	Inköpare	Stämmer delvis inte	Varken eller	Stämmer inte alls	Stämmer delvis inte
Kontor och butik	Produktionschef	Stämmer delvis inte	Stämmer delvis inte	Stämmer delvis inte	Stämmer delvis inte
Sjukhus	Ombud	Stämmer inte alls	Stämmer delvis	Stämmer delvis	Stämmer delvis inte
Kontor	Arbetsledare	Stämmer delvis inte	Stämmer helt	Stämmer delvis inte	Stämmer delvis
Lägenhetshus	Produktionschef	Stämmer delvis inte	Stämmer inte alls	Stämmer delvis inte	Stämmer delvis inte

Appendix K: Survey answers – Comments

This appendix presents the comments that respondents made, regarding the implementation of the different types of TPL solutions.

Comments for TPL managing OSH:

Kommersiellt projekt	Arbetsledare	- Framförallt frigav tredjepartslogistiker på plats tid från egna arbetare, som kunde fokusera på att producera. För arbetsledningen krävdes samma planering då det är ytterligare en part som behöver inkluderas i varje moment. - Frågorna beror av vilken budget som är avsatt till logistik i kalkylen. - Vi använde eget bokningssystem och utgick från egen leveransplanering. TPL hanterade logistik inom arbetsområdet.
Lamellhus: bostäder/handel.	Platschef	- Ökat fokus på kärnverksamhet. - Kostnaderna blir tvärtom lättare att ta på, då de särredovisas på ett enkelt vis.
Lägenheter	Platschef	- Det bästa med Tpl är att vi kan fokusera på att montera och kan även vara färre yrkesarbetare på plats
Köpcenter	Blockchef	- Logistik tog över och började riva upp det som redan fungerade,det ledde till - Mer mtrl. och på fel platser eftersom bokningsystemet inte klarade av att hantera våningar.
Flerbostadshus	Projektingenjör	Intransporter skedde kvällstid så våra YA kunde arbeta på dagarna.

Comments for TPL using CCC:

Kontor och butik	Produktionschef	- Delvis kostnadsdrivande men framför allt svårt att räkna hem affären. - Egen personal som har ”transport” med i ackordet blir lata men vill fortfarande ha samma peng trots att man inte utför alla uppgifter.

Comments for TPL using DBS:

Lägenheter	Inköpare	- Ekonomiskt lönsamt
Handelscentrum	Blockchef	- Dyr lösning men effektiv. - Positivt: vi slapp hantera inkörning av material. Rent och snyggt. - Negativt: Mindre ansvar från TPL att vara rädd om våran produkt(huset), mycket blev sönderkört av dem.