MASTER'S THESIS ACEX30

Optimizing Efficiency and Cost Through Dedicated Logistics Management in Construction Projects

Master's Thesis in the Master's Programme Design Construction in Project Management

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Göteborg, Sweden 2024

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Institutionen för arkitektur och samhällsbyggnadsteknik
Chalmers tekniska högskola, 2024

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Gothenburg, Sweden, 2024

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ABSTRACT

The research identifies that the absence of a specialized logistics team in construction projects leads to tradesmen handling materials, which results in inefficiencies, project delays, compromised deliverable quality, and increased costs due to the misallocation of responsibilities and lack of strategic logistics involvement. The aim of this research study is to provide valuable insights into the tangible benefits of incorporating a dedicated logistics team into construction projects. To gain this insight, it is important to examine how a dedicated logistics management team influences the overall efficiency and cost effectiveness of construction projects, as well as to analyze the challenges of what this team encounters and best practices to increase efficiency of the team. The research draws on the literature that supports this insight in order to get a richer understanding of dedicated logistics management team involvement in construction. The method applied is research based on interviews with construction professionals, surveys taken by professionals worldwide within the industry, and observations from a single construction project case study in Gothenburg, Sweden. The analysis of this observation involved the use of Six Sigma Method and SCOR model frameworks as well as regular consultation with a third-party logistics (TPL) provider based in Gothenburg, Sweden. The findings provide valuable information on how implementation of dedicated logistics management team in the construction project affects the efficiency of the process. The findings also show how investing in a dedicated logistics team from the initial phase of the project justifies the overall project cost, which leads to cost savings in the overall project outcome.

Keywords: logistics, construction, TPL, Six Sigma, SCOR, management

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Preface

This master thesis of 30 credits is the final part of the master programme Design and Construction Project Management ('MDCPM') at Chalmers University of Technology, Sweden. The thesis was carried out from January 2024 to June 2024 at the department of Architecture and Civil Engineering with collaboration of one of our partners, being an industrial developer in the city of Gothenburg, where the name has been classified due to confidentiality of the information shared, and construction logistic company Svensk Bygglogistik AB.

This master's thesis was conducted under the supervision of Associate Professor Dimosthenis Kifokeris from the Construction Management division. We extend our profound gratitude to Associate Professor Kifokeris for his invaluable support, contributions, and consistently positive outlook throughout our research. His dedication, innovative ideas, and unwavering encouragement have been greatly appreciated and have significantly enriched this work.

We would also like to extend our thanks to Emil Jonasson from Svensk Bygglogistik AB for providing us with the opportunity to collaborate on this report and for facilitating connections with experts and professionals in construction logistics management. Additionally, we express our gratitude to the professionals who have invested their time in contributing to our survey and interviews.

Gothenburg, June 2024

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1 Introduction

This chapter introduces the background of the problem identified for the research and why it is significant to analyze and find solutions to it. It follows with the Research Question and the Aim & Objective of this thesis, followed by the methodology of how to answer the research question.

1.1 Background

1.1.1 Problem Identification

The problem highlighted in this research stems from the absence of a dedicated logistics team, that is specialized in the field of logistics, in the construction projects. The absence of such a team necessitates involvement of tradesmen in material handling, while these resources are primarily skilled in specific tasks rather than logistics. This misallocation of responsibilities, when coupled with the absence of strategic involvement of a dedicated logistics team can adversely affect the overall efficiency of the construction project. The resultant effects include delays and disruptions to the project timeline, compromised quality of deliverables, and an escalation in both direct and indirect costs of the project.

1.1.2 Importance of the Problem

Construction logistics management is a critical aspect of any construction project, as it involves the coordination of materials, equipment, and personnel to ensure that the project is completed on time, within budget, and to the required quality standards. In recent years, there has been a growing interest in the implementation of dedicated logistics management teams in the construction industry, with the aim of improving the efficiency, cost-effectiveness, and overall success of construction projects (Sezer, A.A. and Fredriksson, A., 2021).

The importance of the problem arising from inadequate planning in Supply Chain Management (SCM), particularly in the field of logistics within the construction industry, cannot be overstated from an economic perspective. The effects of this

issue extend beyond mere inefficiencies, directly impacting economic factors crucial to sustainable growth. The mismanagement of logistics, or broadly, the absence of dedicated logistics team contributes to the creation of disorganized construction activities that result in, without limitation to, disorganized resource allocation, excessive production of waste, delays in operation and completion of works, and inefficient time management, where all these factors have a common consequence i.e. cost. Not only does it affect the construction project itself, but it also reverberates across various stakeholders including clients, contractors, suppliers, individuals, and everyone intricately involved in the supply chain. The economic fallout is two-fold. First, the construction sector faces escalating costs and reduced operational efficiency due to poor construction logistics planning. Secondly, the broader economic landscape suffers as the escalation of construction costs lead to higher housing costs, higher rents, higher indirect costs of various industries, and indirectly higher inflation in the production cost of end-products. The construction industry's failure to address this issue could have lasting and circulating economic effects, jeopardizing both the industry's viability and the broader economic stability. It is imperative to recognize the economic interconnectedness of this problem and implement effective construction logistics planning and sourcing to mitigate its adverse impact on the construction economy and the broader economy.

According to Linden and Josephson (2013), outsourcing material handling to specialized logistics service providers offers reduction in risk of material unavailability, minimized damage during shifting of materials and storage thereof, and decreased interruptions. The benefits identified above by Linden and Josephson (2013) are, whether in-house or outsourced, aligned with the presence of a dedicated specialized logistics team, and a working plan. Their empirical study suggests that there was a potential cost reduction of approximately 20% of savings, particularly in indirect costs.

Accordingly, a dedicated and empowered logistics team in a construction project can lead to overall cost reduction and increased efficiency with effectively using tradesmen, not interrupting the sequencing and the pace of the works, taking good

care of the goods in movement, those will together positively impact the economy of the construction works. Linden and Josephson (2013) further discussed the challenges of the construction industry due to being resistant to change and implementing new effective working practices. The time and resource constraints hinder the innovation in project-specific construction industry.

Several studies have investigated the impact of dedicated logistics management teams on construction projects. For example, a study by Almohsen and Ruwanpura (2011) found that the implementation of a dedicated logistics management team can lead to significant improvements in project efficiency, as it allows for better coordination of materials and equipment, reduces delays and downtime, and improves communication between stakeholders. Similarly, a study by Bäckstrand and Fredriksson (2020) found that the lack of logistics management in construction projects can lead to inefficiencies, such as long turnaround times, increased costs, and reduced productivity.

Agapiou et al. (1998) found that the role of logistics in the material flow control process is critical to the success of construction projects. Similarly, Skjoett-Larsen (2000) argued that TPL providers can play a significant role in improving the efficiency and effectiveness of construction supply chains.

In the context of residential construction projects, Behera et al. (2015) found that the implementation of a dedicated logistics management team can lead to significant improvements in project delivery times, cost savings, and customer satisfaction. The authors also noted that the use of technology, such as GPS tracking and real-time monitoring, can further enhance the effectiveness of logistics management teams.

In the case of industrial construction projects, Bankvall et al. (2010) highlighted the importance of interdependence in supply chains and projects. The authors argued that the use of dedicated logistics management teams can help to improve coordination and communication between different stakeholders, leading to better project outcomes.

Moreover, Briscone et al. (2004) found that client-led strategies for construction supply chain improvement, which often involve the use of dedicated logistics management teams, can lead to significant improvements in project performance, including cost savings and reduced project duration. In reference to Fang and Ng (2011), there are hidden costs in relation to the construction logistics which have not been explored to be studied (Linden and Josephson, 2013).

In order to determine true cost of arrangements for TPL providers as well as to assess gains in terms of productivity improvement and waste reductions in construction operations, Janne & Rudberg (2022) recommends a carefully designed study that measures the performance of construction TPL providers, comparing them to projects without TPL providers.

1.2 Research Question

The research involves an extensive review of the literature and implementation of empirical studies including survey among the professionals in the industry, interviews with certain key professionals, and a case study of a project to address a fundamental research question:

"*How does the implementation of a dedicated logistics management team impact the efficiency, cost-effectiveness, and overall success of large construction projects?*"

1.3 Aim and Objectives

1.3.1 Aim

The aim of this research study is to provide valuable insights into the tangible benefits of incorporating a dedicated logistics team into construction projects. The findings can guide construction industry practices, emphasizing the importance of strategic logistics planning for improved project outcomes.

1.3.2 Objectives

Objective 1: To examine how a dedicated logistics management team influences the overall efficiency of construction projects.
Method: Conduct interviews with professionals in the industry, particularly the professionals who has mandate on the project management, cost management, quality control, and time management to understand the approach and strategies to enhance project efficiency. Observations on how the material and information flow are handled, how the sites are organized in projects which have different approaches. Furthermore, SCOR model is planned to be integrated as a framework to analyze the supply chain efficiency and Six Sigma methodology to be used to identify and eliminate inefficiencies.

Objective 2: To evaluate the financial benefits and cost effectiveness achieved by incorporating a dedicated logistics team in construction projects.
Method: Conduct interviews with professionals from the industry with the mandate on project management and cost management to understand (i) the costs associated with sourcing a dedicated logistics team, (ii) the considerations taken into account by the professionals who makes strategic decisions to adopt this solution and deploy a dedicated logistics team from a feasibility perspective, and (iii) the perception by the professionals on the cost effectiveness of such solution. Further, analyze cost data obtained from a project, evaluate the cost overruns associated with the logistic problems, and the potential costs of mitigating those problems by deploying a dedicated logistics management team. Retrieving the cost data from the project will further assist in assessing the consequential costs of not having a dedicated logistics team in comparison to the cost of a dedicated logistics team over a period in the project.

Objective 3: To determine the overall success of the construction projects managed with a dedicated logistics team, identifying the key factors of success for construction from the perspective of literature, including the evaluation of project time management, cost management, and quality management.

Method: Analyze the project as a case study, conduct qualitative interviews with managers and if possible, with stakeholders to understand how the practices defined by literature contribute to the project's success.

1.4 Methods

1.4.1 Literature Review

The research is initiated by gathering information through literature review in terms of logistics in the construction industry in relation to the efficiency and cost effectiveness. In addition, the collaboration takes place with two companies to support the thesis where the first company has a construction project that opted out on having a dedicated logistics management team and the second company is a TPL provider.

Literature and the outcomes of various historical empirical studies will shed some light on the research, and such will be further analyzed with empirical data obtained from the surveys, interviews with key professionals, and case study from a real-time project.

1.4.2 Empirical Study

1.4.2.1 Real-Time Project Data

For the purposes of collecting and analyzing data in the empirical studies, we will carry out a case study with a major industrial construction project in Gothenburg, Sweden, (hereafter "Project") where the name of the company and the project particulars are decided to be classified due to confidentiality requirements of the company (hereafter "*Company A*").

The Project is a major industrial project driven by *Company A*, that has opted out the dedicated logistics team in their organization and planned to step down the responsibility of the on-site logistics management to the contractors. The case is studied by regular observations on the logistics issues at the Project site including the strategic planning, material flow, information flow, site facilities, and services.

To complement the data, further empirical study efforts have been planned and conducted in this research including interviews with key professionals in the industry and survey reaching out to diverse profiles in the industry.

1.4.2.2 Survey

In pursuit of understanding the impacts of implementing dedicated logistics teams within the construction industry, a survey was conducted through Microsoft Forms, which targets professionals from various divisions in the industry from all around the world. The survey pursued to examine the perception of the professionals in the industry on how dedicated logistics teams contribute to projects' efficiency, cost-effectiveness, and overall success. This section will present the results obtained from the survey and briefly discuss the reflection thereof.

The Structure and Implementation of the Survey

The survey structure and the platform of application were strategically selected. The survey was created on Microsoft Forms due to its accessibility and user-friendly interface, which is critical to promote higher participation rates. The questions were prepared to have efficient data on the perception of the effectiveness of dedicated logistics team in a construction project from diverse profiling of construction professionals from different experience levels, different backgrounds, responsibilities, and cultures, in order to discuss the subject on a broader perspective.

Participants were selected based on their involvement in the industry, but no other profile categorization was made to collect responses. The participants were asked to respond a series of questions which were carefully designed to capture quantitative and qualitative data that can be categorized as follows:

i. Demographic and Professional Background:

Participants were asked to provide information about the current country where they worked in, the organisation and its role in a project (client, contractor, or consultant), their specific role, and their total years of experience in the industry.

This data helps contextualize the survey responses based on geographical and professional diversity.

ii. Presence and Structure of Logistics Management:

Participants were asked to ascertain whether the organizations they work in have a dedicated team specifically for managing construction logistics, such as material handling, site maintenance, and the strategic movement of equipment and vehicles on site. Additional inquiries determined whether these logistics functions were managed by in-house operatives or outsourced to TPL providers.

iii. Evaluation of Logistics Management Efficacy:

The participants were asked to evaluate the effectiveness of having a dedicated logistics team, and further specific inquiry is made to the perceived impact on project efficiency, cost savings, and the ability to mitigate project delays.

1.4.2.3 Interview

Several semi-structured interviews have been conducted with key professionals in the industry to discuss and retrieve valuable insights with their opinions and experiences. Below Table 1 presents the list of professionals who has taken part in the interviews and contributed to this research:

Interviewee	Total Experience	Main Role
Interviewee 1 - Ray Williams	10 years	Senior Cost Manager
Interviewee 2 - Emil Jonasson	20 years	Chief Executive Officer
Interviewee 3 – Samuel Edwards	30 years	Managing Director
Interviewee 4 - Warren Watts	40 years	Logistics Manager
Interviewee 5 - Roy Whittlestone	28 years	Project Manager
Interviewee 6 - Benjamin Linden	14 years	Programme Manager
Interviewee 7 - Caroline Ernström	15 years	Site Logistics Manager
Interviewee 8 - Magnus Nyström	40 years	Strategic Manager

Table 1 List of interviewees with their experiences and current roles.

1.4.3 Data Analysis

1.4.3.1 Analyze the Result of the Study Using Frameworks

Six Sigma Method

To reduce waste and defects with the tools and techniques, to what is causing the manufacturing process to slow down, how delays can be eliminated, improve the process, and fix further issues along the way.

Supply Chain Operations Reference (SCOR) Model

A model to help deliver value to the customer by purchasing, production and logistics.

2 Literature Review

In order to address this review, it is imperative to consider how logistics is defined and what it includes. According to Agapiou et al. (1998), logistics in construction includes the management of material flow that requires planning, organizing, coordination, and control. However, Sullivan (2010) extended this definition to a systematic approach to material and information flow.

2.1 Efficiency

The efficiency of incorporating a dedicated logistics management team in the construction site is still a topic of debate within academic and professional circles. Scholars and practitioners continue to grapple with differing perspectives on the necessity of a dedicated construction logistic management team.

Linden and Josephson (2013) touch on two contrasting views among professionals regarding material handling. On the one hand, there are those who view material handling as a part of the construction process to be executed as and when required by the available resources. On the other hand, some opposing parties argue that material handling should be regarded as a support function, which signifies careful planning and execution by specialists in the field. This ongoing debate underlines the complexity of logistics management in construction projects and underscores the need for further research and dialogue to reach the most effective approach.

2.1.1 Transportation

Existing research shows that the efficiency of construction logistics is more obvious in urban areas, especially for larger projects. A further review on the paper by Lindholm and Browne (2015) provides valuable insights into improving the construction logistics especially in transportation, particularly within densely populated urban areas such as London and Gothenburg. Construction logistics in urban areas play a more important role in mitigating, if not eliminating entirely, the hindrance to the traffic flow. The disrupted urban traffic will have major impacts extending beyond mere inconvenience, but also impacting various stakeholders

such as businesses around the construction sites and the public who are commuting around the construction site, which potentially increase unexplored economic consequences. An appropriate construction logistics plan, overseen and executed by dedicated professionals, is significant in minimizing such impacts by ensuring timely deliveries and efficient offloading procedures. Such strategic planning not only enhances project efficiency but also contributes to the overall well-being of urban communities and their economic vitality.

2.1.2 Waste Management

Construction logistics management in the traditional way of the construction method has been identified as a significant contributor to the challenges in managing waste in the construction industry. Koskela (1992) criticizes traditional construction management methodologies for their emphasis on value-adding activities rather than focusing on managing waste in an efficient manner. Koskela emphasized the main issues shown in both the nature of construction projects themselves and how it has been managed within the industry.

Due to the complexity of the construction industry, inefficiencies, especially in waste management, occur to a degree that produces a large amount of unnecessary waste i.e. overconsumption of materials and large waste accumulation on-site. In the study, Koskela discovered that the detrimental effect of these inefficiencies leads to a cost escalation of up to 10% in both material and labor expenditure. Beyond how Koskela addressed the definition of waste and its correlation with logistics, Thilakarathna and De Silva (2014) define the waste as activities which do not add value to the final product. Furthermore, Liu et al. (2017) relates 'waste' to the waste of time, cost, and resources in the industry which stem from the complexities and weaknesses of the professionals. Liu et al. (2017) further states that analyzing the non-value-adding activities, including poor communication, may help remove those wastes.

2.1.3 Material Handling

Construction logistics is the control and management of material flow from source to point of use, as well as traditional site services. Taking into consideration resource efficiency and sustainability can have a significant benefit on a whole construction project's sustainability (Lundesjö, 2015).

The use of delivery management system and material logistics planning are addressed as other strategies to influence the effectiveness of the construction logistics and can outperform when combined with a dedicated logistics team, that carry forward specific skills, expertise, and knowledge on systems and equipment. In the research paper done by Lundesjö (2015), it was analyzed that employing a logistics team or logistics manager will ensure that the management of deliveries and distribution materials, equipment and plants are dealt with more effectively. This can help with planning for both smooth and Just-In-Time (JIT) deliveries. It will make sure that double and triple handling is eliminated and that materials are stored and delivered to the correct point and handled only at the point of construction.

In addition, it is also analyzed that a client can promote more effective logistics by including it as criteria within the procurement process. This could entail asking for responses on an organization's logistics strategy and assigning a score to it in the tender evaluation process. Organizations should establish key performance indicators (KPIs) to report on their performance, such as empty miles, driver training, vehicle type, miles driven and carbon effect. (Lundesjö (2015).

Furthermore, Lundesjö (2015) found that skilled labor spends around half their time moving material or unloading lorries. In which case, having a dedicated team of people for this would mean that trade time would be more effectively used and require fewer hours overall. From this analysis, it shows that unproductive labor time on a construction project is spent waiting for materials, or due to materials being at the wrong place and needing to be moved on one or more occasions.

2.2 Cost-Effectiveness

Effective logistic planning plays an important role in construction project management by minimizing the need for reactive problem-solving, which is a process that can drain project resources substantially. Sullivan et al. (2010) highlight the significance of the engagement of specialized logistics managers within construction projects that have shown to be beneficial in terms of mitigating risks and reducing costs.

One of the primary contributions of dedicated construction logistics management teams is in their ability to enhance certainty, productivity, and predictability in navigating the intricacies of project logistics. By properly planning and coordinating the transportation, storage, and distribution of materials and resources, these specialists preemptively identify potential risks to ensure optimal efficiency.

Moreover, the presence of a specialized logistics manager affords construction projects a heightened level of resilience in handling unexpected challenges. Their adeptness in problem solving enables effective responses to emergent issues, thereby averting costly delays and mitigating potential setbacks. By preemptively addressing logistical hurdles, these professionals increase the project's overall success and sustainability, safeguarding against unnecessary expenditure and optimizing resource allocation.

Furthermore, the cost-effectiveness of engaging a dedicated construction logistics management team extends beyond immediate financial considerations. Research indicates that one third of the total heavy vehicles in Sweden come from the construction industry (Sveriges Byggnindustrier, 2020 & Dubois et al., 2019), highlighting the significance of efficient logistics planning in reducing transportation-related costs and environment impact. In an empirical study, Linden and Josephson (2013) suggested a potential cost reduction of approximately 20%, particularly in indirect costs, through effective construction logistics management. Insufficient logistical planning often leads to inefficiencies

in material handling and interruptions in tradesmen's work, resulting in overlooked costs and decreased project efficiency.

The lack of clarity in the costs pertaining to the construction logistics often leads to poor estimates where interruptions in the tradesmen's work and resultant inefficiencies in material handling are overlooked. This also strengthens Sullivan's research in which a dedicated and empowered logistics team in a construction project may lead to overall cost reduction and increased efficiency with effectively using tradesmen, not interrupting the sequencing and the pace of the works, taking good care of the goods in movement, those will together positively impact the economy of the construction works.

Moreover, Fang and Ng (2011) further analyzed construction logistics costs by applying an activity-based costing approach. This approach simplifies construction logistics cost analysis by dividing costs into four major components as follows:

1. Resource consumption during storage.
2. Resource consumption of transportation from supplier to construction site.
3. Resource consumption during loading, fixing and on-site storage.
4. Resource consumption in purchasing department.

By dividing logistics costs into these components, stakeholders gain deeper insights into cost drivers and opportunities for optimization. This includes inventory cost, transportation cost, cost for site storage and procurement cost. The engagement of a dedicated construction logistics management team represents a strategic investment in the success and cost effectiveness of construction projects.

2.3 Challenges and Best Practices

2.3.1 Challenges

Using TPL providers in the construction industry can present some challenges due to the unique nature of construction projects (Jonsson and Rudberg, 2017). Firstly, construction projects are often complex, temporary, and involve many stakeholders. This complexity makes integrating TPL providers into the

construction processes difficult. Additionally, the industry's supply chain is fragmented, and this fragmentation includes many different contractors, subcontractors, and suppliers, which makes it difficult to coordinate under TPL arrangement. Secondly, there is another challenge due to the lack of understanding of TPL in the construction sector compared to other sectors (Dubois and Gadde, 2002). The lack of understanding in question can lead to uncertainties and eventually significant resistance to change among industry professionals. This challenge is further exacerbated by concerns in relation to the cost of implementation and maintenance of TPL providers in the organizations despite their potential contribution to improvements in logistics performance.

Last but not least, one of the greatest challenges in relation to the deployment of TPL providers in the construction industry is to ensure alignment of all the stakeholders regarding the regulations and standards. The construction projects are subject to rigorous scrutiny; hence a logistics business partner has to maintain a high level of efficiency and compliance. Additionally, integration of a TPL provider can introduce additional complications, including potential disruptions to the schedule, quality control, and communication barriers. For this reason, it is imperative to have a solid risk management plan in place (Janné & Rudberg, 2022). In order to ensure efficient and workable integration of TPL providers, all stakeholders in the supply chain require sharing information and collaborating. The problem with this collaboration is because the construction industry is fragmented; however, with the right planning and timely involvement, construction can navigate these challenges and really reap the benefits of bringing in a TPL provider (Janné & Rudberg, 2022).

2.3.2 Best Practices

In the construction industry, TPL providers highlight the importance of assigning material handling to specialized resources for more efficient project execution. Linden and Josephson (2013) suggested that outsourcing material handling can lead to a reduction in risks such as material unavailability, damages during shifting and storing, and interruptions. Such reduction can be achieved through the

presence of dedicated and specialized logistics teams and a comprehensive working logistics plan.

The idea that dedicated logistics management teams significantly contribute to the success of construction projects by coordinating materials, equipment, and personnel (Sezer and Fredriksson, 2021). These dedicated teams offer improved project efficiency and facilitate better communication among stakeholders, which helps to reduce delays and downtime (Almohsen and Ruwanpura, 2011). On the other hand, a lack of logistics management can lead to inefficiencies and increased project costs (Bäckstrand and Fredriksson, 2020).

Agapiou et al. (1998) emphasized that dedicated logistics management team's main role in the construction industry is to control the flow of materials. Similarly, Skjoett-Larsen (2000) noted that TPL providers can enhance efficiency and effectiveness in construction supply chains.

In residential construction, Behera et al. (2015) found that dedicated logistics management teams can significantly improve project delivery times, reduce costs, and enhance customer satisfaction. The use of technology, such as GPS tracking and real-time monitoring, further enhances the performance of logistics management teams.

Bankvall et al. (2010) stated that dedicated logistics management teams improve coordination and communication between different stakeholders, which leads to better project outcomes. Furthermore, Briscone et al (2004) highlighted the benefits of client-led strategies involving dedicated logistics management teams, which result in cost savings and reduced project duration.

In addition, strategic planning is crucial, as Janné and Rudberg (2022) highlighted in their research. It is essential that the TPL providers are fully aligned with the projects' goals. This alignment enables the logistics framework to actively support the broader project goals, fostering a tightly managed and well-coordinated supply chain. Additionally, the significance of the collaboration cannot be overstated;

strong partnerships with TPL providers and other key stakeholders are crucial for running the projects smoothly. When all the stakeholders including the TPL providers are aligned, the logistics in a project becomes much easier to operate.

When evaluating the effectiveness of TPL providers, performance measurement becomes essential. Establishing some clear Key Performance Indicators (KPIs) allows for tracking how efficient logistics operations are running. This provides construction companies with a way to assess the real impact of TPL providers on their projects and identify areas that require improvement. Additionally, the importance of education and training should not be underestimated. By ensuring all individuals and organizations involved in TPL solution become aware of their role and where they stand in the operational processes, the confusion can be reduced, and the overall efficiency of the projects can be improved.

Today, the importance of technology cannot be overstated. Implementing advanced logistics software and tracking systems helps construction companies streamline their supply chain processes and elevate their performance in the execution. Moreover, regular evaluations of the TPL setup and performance are essential for continuous improvement, as building a culture of continuous improvement will ensure that the logistics operation remains highly effective and competitive. Additionally, compliance is another key aspect in the logistics operation. The TPL provider is required to adhere to all applicable law, statutes, regulations, and standards, which ensures safety and avoids potential legal issues.

2.4 Six Sigma Method

Six Sigma is a method that is utilized to analyze new product and service development towards an improved process strategically to create dramatic reductions in customer defined defect rates (Linderman et al. (2003) and Mast & Lokkerbol (2012)).

Six Sigma methodology is vital for the Just-in-Time (JIT) delivery of construction materials, products, and equipment. In their studies, Fischer et al. (2014) used the

Define, Measure, Analyze, Improvement and Control (DMAIC) six sigma method to improve interactions amongst project teams, reduce delays, improve strategy implementation, and increase the efficiency of construction processes (Oakland and Marosszeky, 2017).

DMAIC six sigma method consists of:

1. Define: Determine issues, opportunities for improvement and customer requirements
2. Measure: Analyze the process and the quantity of output generated by gathering data and establishing metrics.
3. Analyze: Establish the origin of the variation or flaw
4. Improvement: Implement solutions to address the root cause
5. Control: Monitor, measure, and make regular adjustments to control implemented solutions, new processes, and future performance thereof

Six sigma method plays a key role in creating value for the customer, enhancing quality and reducing cost. It determines the tools and techniques, to what is causing the manufacturing process to slow down, how delays can be eliminated, improve the process, and fix further issues along the way (Fischer et al, 2014).

The key elements of achieving success in implementing six sigma methodology within construction logistics are as follows:

1. The JIT principle for material handling includes movement and transportation.
2. Clear communication of assignments and plans.
3. Staff training, collaboration, and ability to handle multiple tasks.
4. Daily progress tracking for measurement purposes.
5. Inspired and skilled workforce development.

2.5 Supply Chain Operations Reference (SCOR) Model

The SCOR model is a framework that is commonly used to improve the process in supply chain management. The SCOR model was founded by the Supply Chain

Council with the intention to assist managers to solve the complexity of issues within the supply chain management to be simplified strategically (Huang et al., 2004).

In their studies, Thunberg & Persson (2014) identified the processes consisted within the SCOR model as follows:

1. Plan: Estimate the quantity, method, quality, and cost
2. Source: Purchasing infrastructure and managing resources to meet actual or anticipated demand
3. Make: Manufacturing and defining production process methods to meet planned and actual demand
4. Deliver: Order handling, managing logistics for product delivery to meet planned or actual demand
5. Return: Streamlined return management process

In addition, Thunberg & Persson (2014) found important points of analyzing the SCOR Model in the construction site as follows:

- Perfect Order Fulfillment (POF): evaluating the process of ordering and delivering materials, assessing if the quantity, condition, and delivery were flawless.
- Source Cycle Time (SCT): The duration it takes in identifying suppliers, selection, negotiation, scheduling deliveries, receiving, verifying, transferring to inventory, and authorizing supplier payment.
- Cost to source: Total expenses incurred in manufacturing, delivery, planning, returning, and managing supply chain issues.

3 Empirical Research

In this empirical research section, the research objectives are correlated with the chosen empirical methods, the motivation behind each method and the specific insights intended to be uncovered.

3.1 Project Collaboration

3.1.1 *Company A* – Industrial Project Case Study

The research involved a case study with a highly reputable organization, which is referred to as *Company A* due to strict confidentiality demands, on their on-going *Project* in Gothenburg. The case study intended to evaluate the site operations, logistics performance and the choice of *Company A* regarding the implementation of a dedicated logistics team. The case study with *Company A* and the *Project* in Gothenburg is regarding the performance of works which have been carried out in the early stages of the *Project*, the decisions taken in terms of logistics solutions, logistics management issues during the execution and its implications, and a further discussion on consequences both in efficiency and cost-effectiveness perspectives, alternative approaches, and evaluation of lessons learned.

The *Project* was chosen strategically as *Company A* has decided not to deploy a dedicated logistics management team due to the motivations provided below:
(i) The initial activities included earthworks, such as excavation of soil and rock to level the site, and allow to receive the foundations, casting of foundations, establishment of temporary structures, and erection of structural steel frame. These activities have been heavily dependent on heavy machinery, which returns minimum labor and material flow on the site.
(ii) The *Project*'s plot offered vast area to handle material storage and any necessary on-site flows, and
(iii) Any bottleneck in the logistics due to the presence of many other industrial facilities surrounding the construction site could be handled case by case as no other urban constraints were present.

Company A, acting as the Employer, has decided to have a divided contract scheme without employing a general contractor. This scheme is carried out by procurement of all specialist trade contractors under separate contracts, and supervision and coordination by *Company A*. Based on the reasons set out above, *Company A* has opted out the dedicated logistics team solution and decided to proceed with high level planning and coordination and stepping down some of the logistics responsibilities to the contractors.

3.2 Interview Data Collection

3.2.1 Efficiency

The result of the interview with professionals in the construction industry described how having dedicated logistics management team leads to efficiency in the construction process as follows:

3.2.1.1 Local Procurement and Environmental Benefits

Having a dedicated logistics management team means that more focus is given to being able to source materials locally as this shortens lead times and reduces the risk of project delays. In addition, it is environmentally beneficial as it reduces the distance of transporting the material.

3.2.1.2 Building Strong Supplier Relationships

Establishing and maintaining strong relationships with suppliers is important for effective logistics management. The relationship enables the supplier to put more effort into their work within construction projects, which increases efficiency as well as enhancing the quality of the product. On top of that, it facilitates better coordination and communication which is significant to ensure efficiency in the construction process.

3.2.1.3 Strategic Planning and Adaptation

Strategic planning is part of logistics management, which is key, especially in complex construction projects where material handling can become more challenging due to site congestion and limited space. In addition, as logistics involves the management of not just materials but also equipment and personnels, planning and managing these aspects from the very initial phase of the project is significant. One of the most obvious benefits of having a dedicated logistics management team is the approach of working during nighttime to handle material without disrupting daytime activities.

3.2.1.4 Comparing Manufacturing and Construction Logistics

While the logistics management principles in manufacturing and construction share similarities (considering the majority of the construction process is material handling), the relationship with suppliers in construction differentiates these two industries. In manufacturing, long-term relationships with suppliers can significantly impact project outcomes leading to better pricing, reliability, and trust over time. Therefore, strategically, considering the nature of supplier relationships is significant to maximize efficiency and effectiveness.

3.2.2 Cost-Effectiveness

The interview findings on the cost-effectiveness are categorized into several categories to consolidate the discussions on the construction logistics. The categories are provided as follows:

(i) Strategic Logistics Approaches

According to the interview findings, the cost-effectiveness in the construction industry can be significantly enhanced through strategic logistics approaches, leveraging dedicated and specialized logistics management teams. Engaging TPL providers emerges as a key strategy, with bulk purchasing highlighted as particularly beneficial. The interviews also suggest that bulk purchasing allows companies to secure discounts and reduce administrative and transportation

expenses by minimizing delivery frequency as a strategic involvement starting from the procurement process. Additionally, TPL providers help manage complex procurement issues, especially when sourcing outside the local market, thereby avoiding customs challenges and associated costs. Focusing on local procurement with the support of TPL providers can further streamline processes and enhance cost efficiency. Cases which are touched on in the interviews, such as a laboratory project in Solna, Stockholm, illustrate the substantial cost savings and early project completion achieved through the effective deployment of dedicated logistics teams.

(ii) Role of Efficient Logistics Management

Interviewees highlight the fact that efficient logistics management plays a crucial role in preventing cost overruns by ensuring the timely delivery of materials and effective supply chain management. Both in-house dedicated logistics teams and TPL providers contribute to reducing waste and fostering the reuse of materials, thereby improving profit margins. A well-organized logistics management system mitigates unexpected costs and delays, keeping projects within budget and on schedule. The interviews further referred to certain financial thresholds as per the analysis of an interviewee, such as SEK 200 million, deploying dedicated logistics teams is advised despite the seemingly high initial costs. The deployment of dedicated logistics teams ultimately saves significant amounts of money by enhancing efficiency and reducing unmanaged logistics expenses. Practical examples strengthen the importance of a dedicated logistics team in achieving these outcomes.

(iii) Early Logistics Management Involvement

According to the interviews, involving a dedicated logistics management team at an early stage in the project is critical in various aspects. Early deployment is rather an investment in logistics management which helps prevent costs related to delays, waste, and material damage. This proactive approach often results in cost savings in the amount that is likely to exceed the initial investment amount. Additionally, interviews suggested that long-term relationships with suppliers are beneficial, as they can collaborate and contribute to increased efficiency and cost reduction in

production. Cases referred to in the interviews demonstrate that early and strategic involvement of logistics teams, such as in the Solna laboratory project, leads to significant cost savings and timely project completion.

3.2.3 Challenges and Best Practices

There are several challenges in Construction Logistics Management related to TPL managing accurate lead times for materials being a significant problem, as suppliers might give overly optimistic timelines that can result in unexpected delays, particularly during high demand periods. Therefore, it is necessary to have effective communication and clear contracts with the suppliers as mis ordering and improper storage of materials can lead to project delays and damage cost.
The construction industry is complex as it involves various stakeholders in a short amount of time. Establishing well organized agreements that outline various scenarios and assign risks to appropriate parties is crucial for effectively handling logistics challenges. A dedicated logistics management team becomes a single point of contact which ensures efficient communication, streamlining project management. Concentrating procurement processes enhances efficiency and risk management in procurement, offloading, and inventory management. Embracing innovative logistics solutions such as central databases for material sourcing, off-site construction, and environmentally friendly delivery methods further supports efficiency and sustainability in project logistics. This calls for thorough planning and preparation, hiring experienced logistics managers and making sure that the logistics team works closely with other departments. Ultimately, having a dedicated and skilled logistics team is vital for the successful delivery of any construction project.

To have the logistics management team in a higher hierarchy level, so that their inputs and opinions are heard makes their attempt in strategizing to be more effective. However, challenges still exist due to the reactive nature (fire fighting solution) within the construction industry, which usually values immediate technical solutions more than strategic solutions. Having two different types of personalities, that oppose each other, which are strategy and operative. The logistic

management is best to be carried out in a strategic manner that focuses on the long-term solution and planned out very early in the early stage. On the other hand, in the construction industry, the people who are mostly appraised and appreciated are the people who are more operative, who give solutions on the spot (reactive). Especially if the operative type of person is placed in the management position, who does not look at or see the project in a strategic way. While what really needs to be acknowledged is the quality of the product, not just how to solve a current problem. This is usually the case because after giving a solution on site, the contractor then moves on to another project, so the long-term effect of the solution usually is not part of the thought process. Balancing strategic and operational mindsets within the logistics management team is essential. Recognizing the significance of quality and long-term impacts over immediate problem solving is crucial.

Furthermore, to pay extra initially to ensure that the supplier fulfils certain packing and delivery requirements is a best practice that prevents material damaged and reduces waste. Combining purchasing and strategy from the beginning of the project enhances logistics management. In addition, elevating the logistics management team within the organizational hierarchy ensures their input in strategic decision making. Another challenge identified in timely delivery is that suppliers often prefer to fill delivery trucks to the maximum capacity, which can lead to additional transportation costs. However, these costs are justified when compared to the potential damage to materials left unprotected on-site, making the additional expense worthwhile.

The construction industry also faces an interesting challenge where the relationship with the suppliers is mostly short-term. Which causes suppliers to avoid providing input and effort as they would normally do with a manufacturing company. This also affects how the materials are delivered, packaged and allocated not to what the client desires. This is due to the nature of working in the construction industry where the supplier who usually wins the tenders is the one with the lowest price.

Logistics management in construction is usually underestimated despite its critical role. Smooth logistics operations seldom receive credit, while any disruption draws significant complaints. Effective logistics management can lead to cost reduction, improved quality, and shorter project timelines, particularly in larger projects. Whereas for smaller projects, internal handling by existing laborers may be more efficient than hiring a dedicated logistics team.

Challenges also include the scarcity of external dedicated logistics teams with proper credentials, complicating compliance with union regulations. Standard pricing by labor unions, which includes material handling, discourages contractors from assigning specialized logistics teams.

3.3 Survey Data Collection and Summary

3.3.1 Survey Responses

The survey conducted under this research has secured fifty-three responses from professionals in the construction industry. The review and evaluation of the responses are categorized into two sections: (i) respondents' profiling, and (ii) reflection.

3.3.1.1 Respondents' Profiling

Although the audience, which the survey has reached out, spread to various countries including the United Kingdom, United Arab Emirates, Qatar, Australia, Germany, Sweden, and Turkey, the participation rate, in other words, the interest in attending to the survey is comparatively much more by the Swedish construction professionals, which is recorded as 55% of the total respondents, i.e., 29 out of 53. This ratio suggests an immature, but indicative perception that the '*logistics*' subject in construction industry attracts a higher level of interest among construction professionals residing and working in Sweden. The rest of the participation is followed up by correspondents from Australia (9%; 5 out of 53), United Arab Emirates (9%; 5 out of 53), and Turkey (8%; 4 out of 53). Table 2

represents the overall distribution of the countries where the correspondents reside and work in.

Respondents' Residence	Nr of Respondents	Distribution %
Sweden	29	54,72%
Australia	5	9,43%
United Arab Emirates	5	9,43%
Turkey	4	7,55%
Denmark	2	3,77%
Indonesia	2	3,77%
Scotland	2	3,77%
Canada	1	1,89%
Germany	1	1,89%
Russia	1	1,89%
Saudi Arabia	1	1,89%
	53	**100%**

Table 2 Distribution of countries where the participants reside.

The survey responses suggest a fair distribution of respondents across various industry stakeholders. The majority of respondents are employed on the contractor side (43%; 23 out of 53), while the client/employer and consultant sides each account for 28% of the participants (each 15 out of 53). This indicates a balanced representation of correspondents from different stakeholders in the industry. Table 3 provides the overall organizational distribution of the correspondents.

Organization in the Industry	Nr of Respondents	Distribution %
Contractor	23	43,40%
Consultant	15	28,30%
Client / Employer	15	28,30%
	53	**100%**

Table 3 Distribution of organizations the participants work in the industry.

The survey aimed to evaluate the perception on the effectiveness of deployment of dedicated logistics teams in the construction industry, primarily on the cost-

effectiveness. To ensure a comprehensive and credible assessment, it was essential to gather reflections from a diverse pool of correspondents with various roles. The collected data indicates a higher level of interest among cost controllers/quantity surveyors (26%; 14 out of 53) and project management professionals (26%; 14 out of 53), in contrast to other critical roles such as commercial and contracts professionals (11%; 6 out of 53), scheduling and planning professionals (9%; 5 out of 53), construction management/supervision professionals (8%; 4 out of 53), and logistics professionals (8%; 4 out of 53). Table 4 represents the distribution of roles of the correspondents in the industry.

Respondents' Role in their Organization	**Nr of Respondents**	**Distribution %**
Cost Control / Quantity Surveying	14	26,42%
Project Management	14	26,42%
Commercial / Contracts	6	11,32%
Scheduling / Planning	5	9,43%
Construction Management / Site Supervision	4	7,55%
Logistics	4	7,55%
Architect	2	3,77%
Finance	1	1,89%
Quality Control	1	1,89%
Strategic Planning	1	1,89%
Sustainability	1	1,89%
	53	**100%**

Table 4 Distribution of the roles of the participants in the industry.

The survey results suggest that participation is characterized by a high level of experience, where 64% of the participants i.e. 34 out of 53, reportedly have ten or more years of industry experience. Additionally, 28% of the participants i.e. 15 out of 53, report 5 to 10 years of experience, and only 8% of the participants i.e. 4 out of 53, have 2 to 5 years of experience, which is considered the minimum threshold.

Profiling with experience was a significant criterion as an extensive experience in the industry is essential for providing credible reflections aligned with practical insights. The responses to the survey in terms of experience indicate a certain level of credibility has been achieved. Table 5 represents the distribution of the participants in accordance with their experience in the industry.

Experience in the Industry	Nr of Respondents	Distribution %
More than 10 years	34	64,15%
5-10 years	15	28,30%
2-5 years	4	7,55%
	53	**100%**

Table 5 Distribution of the participants in accordance with their experience in the industry.

3.3.1.2 Reflection

The data collected from the survey has, in the previous section, profiled the correspondents to evaluate their responses in conjunction with their background. In this section, the questions are formed, and the responses collected are more relevant to the aim of the research where the perception of the efficiency and cost-effectiveness of the dedicated logistics team is discussed.

The survey has further returned data about whether the correspondents have experience with a dedicated logistics management team to handle all the construction logistics matters, and the responses suggest that significant part of the participants (68%; 36 out of 53) have used a dedicated logistics team. Table 6 represents the distribution of the participants whether they have used a dedicated logistics team or not.

Dedicated Logistics Team in the Organization	Nr of Respondents	Distribution %
Worked with a Dedicated Logistics Team	36	67,92%
- *of which with Third-Party Logistics Team*	18	*33,96%*
- *of which with in-house Logistics Team*	18	*33,96%*

Dedicated Logistics Team in the Organization	Nr of Respondents	Distribution %
Did not work with a Dedicated Logistics Team	17	32,08%
	53	**100%**

Table 6 Distribution of the participants if they have used a dedicated logistics team in their organization.

Based on the experience with a dedicated logistics management team, the following question in the survey queried whether the participants have experienced dedicated logistics management by a TPL provider or by in-house organization. The responses collected under this question to the following question can be evaluated in two stages: (i) the proportion of the participants who has outsourced the logistics solution to a TPL provider, and (ii) the proportion of the participants who had dedicated logistics teams in their organization and out of those, who has opted to have this by a TPL provider.

The survey results, when read in conjunction with each other, suggest that half of the participants who have experience with a dedicated logistics team has experienced it with a TPL provider, and the other half has used in-house dedicated logistics teams.

Table 6 also represents the distribution of the correspondents with their choice of TPL solutions. Accordingly, half of the correspondents (50%; 18 out of 36), who had experience with a dedicated logistics team, and 34% (18 out of 53) of overall participation, have experienced a TPL provider. Whereas the other half of the correspondents who had experience with a dedicated logistics team had it through in-house dedicated logistics teams.

This set of responses is further elaborated to evaluate the reflection of the correspondents regarding their experience with TPL solutions and the perceived benefits thereof. The options of the question in this regard were scaling from 'Very Beneficial' (5) to 'Somewhat Beneficial' (4), 'Neutral' (3), 'Not Beneficial' (2), and 'Just Another Cost' (1). The majority of the correspondents who have worked with

a TPL provider (94%; 17 out of 18) found it either 'Very Beneficial' or 'Somewhat Beneficial'; whilst only one of the participants identified it as 'Just Another Cost' (2%). Table 7 represents the reflection of the correspondents based on their experience about how beneficial they found the choice of TPL solutions.

Experience of Third-Party Logistics Team	**Nr of Respondents**	**Distribution %**
Worked with a Dedicated Logistics Team	36	67,92%
- ***of which with Third-Party Logistics Team***	**18**	***33,96%***
that finds it Very Beneficial	*5*	*9,43%*
that finds it Somewhat Beneficial	*12*	*22,64%*
that finds it Neutral	*0*	*0,00%*
that finds it Not Beneficial	*0*	*0,00%*
that finds it Just Another Cost	*1*	*1,89%*
- *of which with in-house Logistics Team*	*18*	*33,96%*
Did not work with a Dedicated Logistics Team	17	32,08%

Table 7 Experience of the participants on how beneficial they found the choice of a third-party logistics solutions.

Following the evaluation of the benefits, the survey further queried whether the correspondents could have identified any cost overruns due to issues pertaining to lack of or inefficient logistics management in the construction industry. A significant number of the participants (85%; 45 out of 53) have stated that they have encountered cost overruns in their projects due to logistics management issues. The firm response to this question strengthens the perception that logistics management is to be further studied to improve and align with the practices in the industry to control the cost and make sure undue cost overruns are avoided. Table 8 demonstrates the proportion of the participants who have encountered cost overruns due to logistics issues.

Experienced Cost Overruns due to Logistics	Nr of Respondents	Distribution %
Yes - experienced cost overruns	45	84,91%
No - did not experience cost overruns	8	15,09%
	53	**100%**

Table 8 Distribution of participants who has encountered cost overruns due to logistics issues.

In the final stage of the survey, the correspondents were asked to provide at a scale from 'Strongly Disagree' (1) to 'Disagree' (2), 'Neutral' (3), 'Agree' (4), and 'Strongly Agree' (5), their perception on the effect of dedicated logistic teams on (i) time, (ii) cost, and (iii) overall efficiency.

The data collected from the final reflection part have been categorized into consideration the correspondents that had a dedicated logistics team in their projects and the ones who had not. The perception of efficiency is considered more consistent when combined with the real experience; however, the results from the participants without any experience with a dedicated logistics team seems to be aligned with the ones with such experience. For ease of evaluation of the reflection, the scale is provided within Table 9 below, which provides the distribution of the correspondents with their reflection on the effect of having dedicated logistics management team on the time, cost, and overall efficiency.

Reflections on Effects of Dedicated Logistics Team	Nr of Respondents	Distribution %
Prevents undue delays	**53**	**100,00%**
Experienced with Dedicated Logistics Team		
5 - Strongly Agree	13	24,53%
4 - Agree	13	24,53%
3 - Neutral	9	16,98%
2- Disagree	0	0,00%
1 - Strongly Disagree	0	0,00%
0 - N/A	1	1,89%
No Experience with Dedicated Logistics Team		
5 - Strongly Agree	7	13,21%
4 - Agree	9	16,98%
3 - Neutral	1	1,89%
2- Disagree	0	0,00%

Reflections on Effects of Dedicated Logistics Team	Nr of Respondents	Distribution %
1 - Strongly Disagree	0	0,00%
0 - N/A	0	0,00%
Saves Cost	**53**	**100,00%**
Experienced with Dedicated Logistics Team		
5 - Strongly Agree	12	22,64%
4 - Agree	16	30,19%
3 - Neutral	6	11,32%
2- Disagree	1	1,89%
1 - Strongly Disagree	0	0,00%
0 - N/A	1	1,89%
No Experience with Dedicated Logistics Team		
5 - Strongly Agree	6	11,32%
4 - Agree	6	11,32%
3 - Neutral	5	9,43%
2- Disagree	0	0,00%
1 - Strongly Disagree	0	0,00%
0 - N/A	0	0,00%
Affects overall efficiency	**53**	**100,00%**
Experienced with Dedicated Logistics Team		
5 - Strongly Agree	16	30,19%
4 - Agree	15	28,30%
3 - Neutral	2	3,77%
2- Disagree	1	1,89%
1 - Strongly Disagree	1	1,89%
0 - N/A	1	1,89%
No Experience with Dedicated Logistics Team		
5 - Strongly Agree	8	15,09%
4 - Agree	8	15,09%
3 - Neutral	1	1,89%
2- Disagree	0	0,00%
1 - Strongly Disagree	0	0,00%
0 - N/A	0	0,00%

Table 9 Participants reflection on the effects of dedicated logistics team on the efficiency, cost, and time.

Table 10 provided below further evaluates the weighted grading in line with the scale from 1 to 5:

Weighted Grading of Reflections	**Grade**	**Ratio %**
Prevents undue delays		
Experienced with Dedicated Logistics Team	4,00	80,00%
No Experience with Dedicated Logistics Team	4,35	87,00%
Saves Cost		
Experienced with Dedicated Logistics Team	4,00	80,00%
No Experience with Dedicated Logistics Team	4,06	81,20%
Affects overall efficiency		
Experienced with Dedicated Logistics Team	4,14	82,80%
No Experience with Dedicated Logistics Team	4,41	88,20%

Table 10 Weighted grading of the reflection from the participants on the effects of dedicated logistics team on the efficiency, cost, and time.

The categorized responses above regarding the effect of having a dedicated logistics team consolidates the reflection that the correspondents, whether they have worked or not with a dedicated logistics team has 'agreed' to 'strongly agreed' that such dedicated logistics team has a positive impact on the overall efficiency, saves significant cost, and prevents undue delays.

4 Analysis and Discussion

4.1 Project Case Study

The case study investigating the Project identified three significant logistical issues that arose during the early construction phase. These issues, which directly impacted the efficiency and resulted in additional costs, were:

- **Unforeseen Mobilization Date Changes**
  The agreed mobilization date of a specific overseas contractor was changed due to the availability of the site to accommodate the resources and the materials.
- **Double Handling**
  The excavated soil was handled twice, i.e. twice the required loading, unloading, and transportation.
- **Equipment Changes Due to Access Issues**
  Deficient logistics planning regarding the access provisions necessitated changes in the equipment to access different areas for disposal of excavated materials.

The research employed both the Six Sigma method and the Supply Chain Operations Reference (SCOR) model. This approach reflects the recognition that construction logistics have many similarities with supply chain management. Establishing a unified and well-coordinated supply chain presents a notable chance to realize the objective of delivering value to consumers at minimal expense through expanding the scope of control and influence (Oakland J.S., 1995).

4.1.1 Analysis using Six Sigma Principles and SCOR Method

As *Company A* has not agreed to the necessity to deploy a dedicated logistics team, the Project has encountered some unexpected logistical issues that result in significant disruptions and additional costs as briefed above. These issues are found to cost the Project approximately SEK 12 million, and they were further reviewed in detail and the relevant methods were applied as follows:

4.1.1.1 Unforeseen Mobilization Date Changes

A critical aspect of efficient construction logistics management is ensuring the timely mobilization of contractors, their resources, materials, and equipment. The issue identified in the Project relates to an unforeseen delay in securing the necessary access for a specific overseas contractor, which has stemmed from the lack of coordination and communication of the site availability and changes in the site logistics planning with the relevant contractor in a timely manner. This has resulted in a domino effect of negative consequences.

Firstly, the planned mobilization of the contractor was hindered. This initial delay triggered a chain reaction of downstream impacts e.g. the contractor has incurred additional costs for delayed transportation and accommodation due to the unexpected delay in their deployment.

Furthermore, the disruption to the timely mobilization introduces significant financial risks, which may have a further cascading effect, pushing back subsequent critical milestones and potentially jeopardizing the Project's overall completion date. At the time of review of the issue, these potential consequences have not been addressed in detail to the full extent it may impact the Project, yet, creating uncertainty and potentially exacerbating the Project's budget and the timeline. The deficiencies in the communication for reconfiguration of the mobilization of the contractor in question has, to the extent that this research has identified, resulted in a cost of SEK 75,000.

To mitigate these risks, construction projects require meticulous logistical planning. Clear communication and collaboration between all stakeholders, including contractors, site personnel, and permitting authorities, are essential to ensure a smooth and timely mobilization process.

a) Analysis by SCOR Model

I. Plan:

Original site planning, targeted cost and quality

The contractor in question was to mobilize to the Project site on a given and agreed upon date, including mobilization of their resources, equipment, and materials from Poland. The site facilities and progress were supposed to be made available to accommodate the mobilized materials, equipment, and personnel to allow them to start their works effectively.

II. Source:

Sourcing the infrastructure or resources to meet the actual plan

Problem: The resources planned for the works, materials to be used, and the equipment to be utilized were not sourced on time due to changes in the site logistics plan and lack of communication thereof.

Impact: Contractor's mobilization was disrupted, leading to additional costs including transportation, accommodation, cancellation of certain fees.

Consequences: The identified cost of SEK 75,000 represents the additional expenditure incurred by the contractor due to the changes in the mobilization plans.

III. Make:

Manufacturing and production (define how to make) to meet planned or actual demand

Remark: *This category may not directly be applicable in the construction context.*

IV. Deliver:

Order processing and transportation (overseeing the logistics of product delivery to satisfy anticipated or real demand)

Problem: The delivery of the contractor's resources and accordingly the services of the contractor were delayed.

Impact: Disruption to the construction schedule and potential delays in the subsequent critical milestones.

Consequences: Increased costs and the risk of further delays in the Project timeline.

V. Return:

Efficient return management, which in the case of material, that was transported to site, it would be how efficient the return of the material process was

Remark: *This is not directly applicable to the scenario as the focus is on mobilization rather than returning goods.*

Recommendations:

1. Establish clear, continuous, unimpeded communication channels among all stakeholders during both the planning and the execution phases for improved collaboration and timely updates.
2. Improve logistics planning by incorporating contingency plans, i.e. robust planning.
3. Conduct frequent risk assessment to identify potential issues early and develop strategies to address them.

b) Analysis by Six Sigma Method

I. Define:

Identify the issue, opportunities for improvement and customer requirements.

Identified Issue: A contractor who was to mobilize from another country to carry out the works as agreed upon in the contract was delayed during mobilization due to lack of communication regarding site access and changes in logistics planning which has costed the Project an identified sum of SEK 75,000, as documented so far, potential delays to the Project's critical milestones, and disruptions to the activities.

II. Measure:

Analyze the process and the quantity of output generated by gathering data and establishing metrics.

Data Collection: Records of changes to the site logistics plans and cost for the contractor's additional transportation and accommodation expenses were reviewed.

Metrics: The mobilization was forced for one week, and the cost per day was over SEK 10,000. Further impacts on the timeline were not yet assessed at the time of the observations.

III. Analyze:

Determine the underlying cause and evaluate the effects

The root causes of the issue were identified to be (i) delayed readiness of the site to accommodate the contractor's mobilization, and (ii) lack of coordination and communication, i.e. information flow during the planning phase. Other factors that potentially contributed to the issue could be identified by various other tools such as cause & effect diagrams.

IV. Improve:

Implement solutions to address the root cause

The solutions to be implemented require addressing the identified root causes as above, which should include: (i) establishment of a clear and unimpeded information flow for all stakeholders, (ii) establish a system for timely updates regarding the changes on the site logistics plans.

V. Control:

Monitor, measure, and make regular adjustments to control implemented solutions, new processes, and future performance thereof.

The solutions proposed require to be performed, monitored, and measured continuously to make sure it is not only controlled but offers ample opportunity to improve by further reviews and periodic audits. The control step requires a full time dedicated responsible to implement and control the solutions.

4.1.1.2 Double Handling

The supervision team in the Project has faced significant restrictions due to the lack of dedicated personnel across various disciplines and absence of a specialized logistics responsible to oversee and coordinate all trades, disciplines, deliverables, and the relevant schedules. These shortcomings in the supervision and coordination led to a major issue where excavated materials have been dumped in areas which were designated for future utility installations planned for the coming months.

The misplacement of the excavated materials required removal and relocation, resulting in literally double handling. This is further complicated by initial misjudgments regarding the designated dumping grounds on site, which has resulted in misleading assumptions about the distance to dumping grounds, causing the excavated materials to be transported over longer distances than initially planned and estimated. Consequently, this has increased the cost of transport operation, as well as the durations the overall excavation work takes. The identified cost for the overall double handling that relates to the specific area has cost the Project approximately SEK 3,200,000 without considering any impact on the timeline and associated delay costs.

a) Analysis by SCOR Model

I. Plan:

original site planning, targeted cost and quality

During, and even before the earthworks commenced, the planning for the excavated materials were made, and the relevant earthworks contractor has allowed for transporting the excavated materials to pre-defined on-site dumping grounds. These plans were essential to accommodate a feasible, practical, and effective progress by the contractor.

II. Source:

sourcing the infrastructure or resources to meet the actual plan

Problem: The initial misjudgments about the designated dumping grounds and the lack of a dedicated logistics team led to inefficient use of resources.

Impact: Misleading estimations about the distance to dumping grounds resulted in transporting materials over longer distances than planned.

Consequences: The overall cost of double handling was approximately SEK 3,200,000, not accounting for any impact on the Project's timeline and associated delay costs.

III. Make:

manufacturing and production (define how to make) to meet planned or actual demand

Remark: *This category may not directly be applicable in the construction context.*

IV. Deliver:

Order processing and transportation (overseeing the logistics of product delivery to satisfy anticipated or real demand)

Problem: The process for moving excavated materials was inefficient due to the initial misjudgments and subsequent need for double handling.

Impact: Increased transport distances and cycle times led to higher costs and extended Project's durations.

Consequences: Significant financial impact and potential delays in project completion.

V. Return:

efficient return management, which in the case of material, that was transported to site, it would be how efficient the return of the material process was

Remark: *This is not directly applicable to the scenario as the focus is on the mobilization rather than returning goods.*

Recommendations:

1. Establish a dedicated and specialized logistics management team to oversee and coordinate all the work to strategically involve in the planning to prevent misjudgments.
2. Utilize real-time tracking and efficient logistics planning to minimize if not avoid undue double handling and other transport inefficiencies.
3. Maintain dedicated logistics team to review and adjust planning, and delivery processes to ensure on-going efficiency and cost-effectiveness.

b) Analysis by Six Sigma Method

I. Define:

Identify the issue, opportunities for improvement and customer requirements.

Identified Issue: The supervision team faced significant restrictions due to a lack of dedicated personnel and a specialized logistics team, which led to the misplacement of excavated materials in areas designated for future utility installations. This required the delivery team to remove and relocate the misplaced materials, which resulted in double handling and increased costs.

II. Measure:

Analyze the process and the quantity of output generated by gathering data and establishing metrics.

Data Collection: Records of events leading to misplacement of materials, the deployed equipment and resources and the cost for the double handling were reviewed.

Metrics: The cost for all the equipment and the resources utilized for double handling are approximately SEK 3,200,000.

III. Analyze:

Determine the underlying cause and evaluate the effects

The root causes of the issue identified were (i) lack of dedicated and specialized logistics team, (ii) misjudgment regarding the location of dumping grounds, and (iii) deficiencies in communication and coordination across various supervisory personnel and contractors.

IV. Improve:

Implement solutions to address the root cause.

The solutions to be implemented require addressing the identified root causes as above, which should include: (i) deployment of additional dedicated personnel and establish a specialized logistics team to oversee the coordination, (ii) develop a comprehensive logistics plan, and (iii) implement regular coordination meetings and communication protocols among all stakeholders.

V. Control:

Monitor, measure, and make regular adjustments to control implemented solutions, new processes, and future performance thereof.

The solutions proposed require to be performed, monitored, and measured continuously to make sure it is not only controlled but offers ample opportunity to improve by further reviews and periodic audits. The control step requires a full-time dedicated and specialized logistics management team to implement and control the solutions.

4.1.1.3 Equipment Changes Due to Access Issues

Another major logistics problem arose during the early earthworks phase of the Project. The basis of the problem lay in a discrepancy between planned and actual on-site access capabilities. While the earthworks contractor had based their plan, execution strategy, and budget on the utilization of larger trucks, the on-site access roads were constructed smaller than originally specified. This unforeseen limitation severely restricted access for the larger trucks, necessitating a change in the nature of the works.

The contractor was forced to adapt by employing a fleet of additional, smaller trucks to handle the loading and transportation of excavated materials. While this alternative approach allowed them to complete the earthworks, it came at a substantial cost. The deployment of additional equipment, allocation of extra manpower to operate the smaller trucks, and the inherently slower excavation process due to their reduced capacity resulted in significant cost overruns. The Project has incurred approximately SEK 8,500,000 as additional expenditure associated with this unforeseen logistics problem.

This situation highlights the importance of meticulous planning and clear communication during the construction phase. Ensuring all stakeholders are on the same page regarding planning the on-site logistics arrangements including the access provisions is crucial. Early identification and rectification of discrepancies between plans and reality can minimize rework, and further incorporating the realities of the site to the procurement process could have avoided a great portion

of the risks incurred by these circumstances. Developing contingency plans to address unforeseen circumstances, like access restrictions, can further mitigate delays and cost overruns.

a) Analysis by SCOR Model

I. Plan:

original site planning, targeted cost and quality

The original plan was to use certain equipment that can access all the locations around the site with the on-site access routes. The cycle of the works, number of equipment to be used, and the total hours to be invested were crucial part of the contractor's estimation.

II. Source:

sourcing the infrastructure or resources to meet the actual plan

Problem: The initial sourcing of the earthworks was to carry out the material transportation for specific areas by large trucks, which turned out to be inconsistent assumption when the on-site access provisions did not meet the initial plan during the sourcing.

Impact: The contractor had to source additional smaller trucks and other resources to operate and adapt to the different access provisions.

Consequences: The deployment of additional smaller trucks and other resources resulted in significant additional costs to the Project.

III. Make:

manufacturing and production (define how to make) to meet planned or actual demand

Remark: *This category may not directly be applicable in the construction context.*

IV. Deliver:

Order processing and transportation (overseeing the logistics of product delivery to satisfy anticipated or real demand)

Problem: The delivery of excavated materials to the off-site recipient was inefficient due to the need for additional smaller trucks which resulted in more cycles to transport the initially planned materials.

Impact: Increased number of trucks, additional trips, and longer cycle times for on-site transportation.

Consequences: The longer cycle times and additional trips result in extended durations and additional transportation costs.

V. Return:

efficient return management, which in the case of material, that was transported to site, it would be how efficient the return of the material process was

Remark: *This is not directly applicable to the scenario as the focus is on mobilization rather than returning goods.*

Recommendations:

1. Ensure clear communication and involve all relevant stakeholders during the procurement to set the requirements, operability, and the actual conditions on-site.
2. Consolidate and incorporate the parameters from different disciplines and strategically support the procurement for an efficient supply chain operation.
3. Regularly assess the site and update the on-site logistics plan and communicate with all the stakeholders.

b) Analysis by Six Sigma Method (DMAIC)

I. Define:

Identify the issue, opportunities for improvement and customer requirements.

The discrepancy between planned and contracted on-site access provisions when compared to the actual on-site access provided led to major restrictions on the contractor for earthworks to use the intended larger trucks, forcing the contractor to use additional smaller trucks, which resulted in substantial cost overruns and inefficiencies in the process.

II. Measure:

Analyze the process and the quantity of output generated by gathering data and establishing metrics.

Data Collection: Records of events leading to the disconnect between the considerations and qualifications in the procurement process and the actual performed access provisions, the deployed additional equipment and resources, and the cost for the double handling were reviewed.

Metrics: The cost for all the additional equipment, the increased number of cycles, and resources utilized to tackle the limitations in the access provisions being approximately SEK 8,500,000.

III. Analyze:

Determine the underlying cause and evaluate the effects

The root causes of the issue identified were (i) deficiency in strategic alignment between the procurement and the site logistics arrangements, and (ii) lack of clear communication, i.e. information flow.

IV. Improve:

Implement solutions to address the root cause.

The solutions to be implemented require addressing the identified root causes as above, which should include: (i) development of strategic involvement and coordination of logistics planning with the procurement, and supply chain operation, (ii) establishing effective communication means among internal and external stakeholders, and (iii) conduct regular site assessments and communicate any disruptions to and deviations from the agreed upon plans with the contractors on time.

V. Control:

Monitor, measure, and make regular adjustments to control implemented solutions, new processes, and future performance thereof.

The solutions proposed require to be performed, monitored, and measured continuously to make sure it is not only controlled but offers ample opportunity

to improve by further reviews and periodic audits. The control step requires a full time dedicated and specialized logistics management team by early involvement in strategic decisions, aligning all internal and external stakeholders, and establishing an efficient site logistics plan with smooth communication protocols to maintain healthy information flow including any deviations, updates, or any unforeseen disruptions to the original plans.

4.1.2 Discussion using Six Sigma Principles and SCOR Method

The utilization of SCOR and Six Sigma method in the research project was inspired to measure efficiency in the manufacturing industry, as logistics management within the construction industry is as significant as it is in the manufacturing industry. The discussion resulted in concluding that some parts of the phases in the construction industry cannot be compared to the manufacturing industry as the process of material handling from one phase to another has different flows, as shown in Figure 1 below.

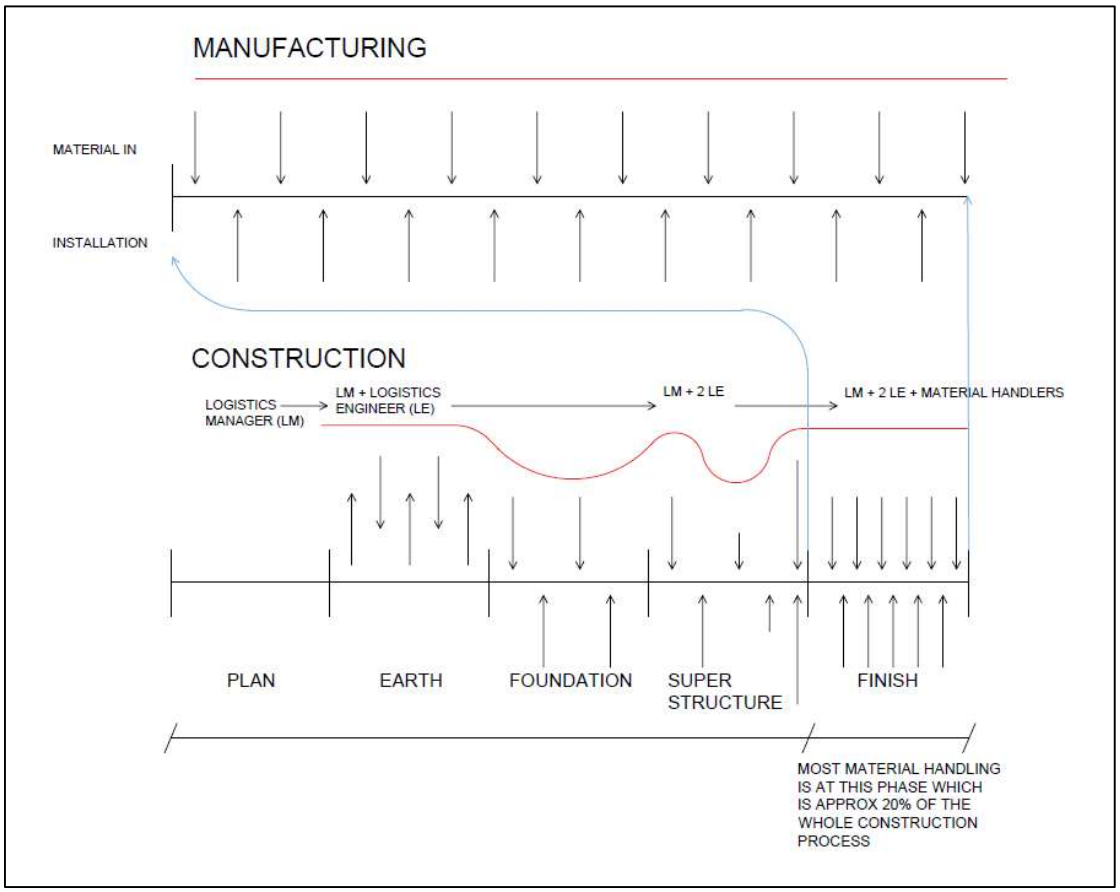

Figure 1 Differences in the process in comparison of Manufacturing and Construction industries.

From our discussion above, we see that the phase in construction that is comparable to the manufacturing industry is the finish section, which is indicated with the blue line, and which is approximately 20% of the whole phase of the construction project. The red line indicates the stability of the project in terms of material handling. In this diagram, we also indicate the times when a dedicated logistics management team enters the project.

This conclusion was further shown in the analysis done through the SCOR and Six Sigma methods that were used to analyze the three cases. These cases were based on an observation done in the initial part of the construction process, where it was shown that the SCOR model used to analyze the cases was not as effective as it would be in the manufacturing industry. Although, the Six Sigma method was effective to determine solutions for the identified issues and how to mitigate the risk of the problems occurring again in the future.

Therefore, it is concluded that the Six Sigma method is more effective to be used in the whole process of a construction in comparison to the SCOR model, which is more effective to be used more in the procurement process.

4.1.3 Cost Analysis should a TPL be Assigned to the Project

Following the identified logistics issues, the potential resolution of such problems has been further evaluated and discussed with Emil Jonasson, being the CEO of Svensk Bygglogistik AB. In consideration of the attributes of the Project of *Company A* provided, the logistics solution offered by Emil was mainly focusing on strategic planning, formation of logistics plan and alignment amongst the delivery teams, procurement, site supervision, and potential contractors by early involvement of a Logistics Manager. Given the role of Logistics Manager, as detailed further by the job description provided hereunder, the early involvement would further facilitate (i) creation of the project's logistics plan including logistics flows, routines, rules, (ii) administration of the logistics plan throughout the project with all the stakeholders, and (iii) ensuring the effective information flow among the relevant stakeholders through logistics meetings.

For this reason, the scenario that would ideally offer a logistics solution with a dedicated team over a total nine-month period will start the Logistics Manager from the first month as full time. In accordance with the increasing workload and requirement of coordination at site, at the peak, the Project will require additional three logistics engineers/delivery planners who ensure day-to-day logistics planning and minimizing hindrances and maintaining the adherence to the logistics plan. As the Project do not require a manual material handling support, the dedicated logistics team as the solution is limited to a total of four resources, which is further supported using dedicated software for coordinating and communicating the flows within the site among all the stakeholders.

The proposed organization is depicted in Figure 2 below:

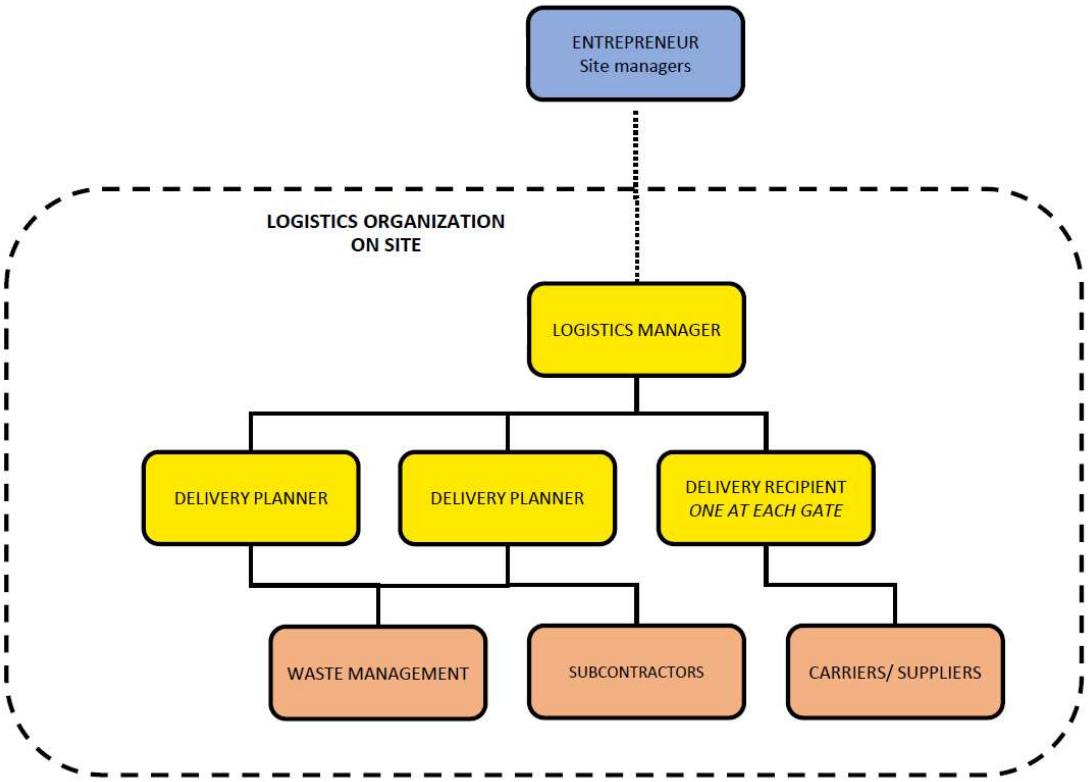

Figure 2 Dedicated Logistics Management Team organizational chart.

The cost of deploying a dedicated logistics team over the nine-month period of analysis is calculated with the tentative monthly costs of the resources and the software, which is tabulated in Table 11 below.

Resource	Cost / Month (SEK)	Total Months	Amount (SEK)
Logistics Manager	127 200	9	1 144 800
Logistics Engineer / Delivery Planner	95 200	7	666 400
Logistics Engineer / Delivery Planner	95 200	6	571 200
Logistics Engineer / Delivery Planner	95 200	4	380 800
LogNet (Software)	10 000	9	90 000
Total in SEK			**2 853 200**

Table 11 Cost breakdown for Logistics resources and the digital application.

The distribution of the resources and their plan over the time is provided through Table 12 below.

Resource Planning & Distribution									
Resource	**aug-23**	**sep-23**	**okt-23**	**nov-23**	**dec-23**	**jan-24**	**feb-24**	**mar-24**	**apr-24**
Logistics Manager	100%	100%	100%	100%	100%	100%	100%	100%	100%
Logistics Engineer / Delivery Planner (1)			100%	100%	100%	100%	100%	100%	100%
Logistics Engineer / Delivery Planner (2)				100%	100%	100%	100%	100%	100%
Logistics Engineer / Delivery Planner (3)						100%	100%	100%	100%
LogNet (Software)	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 12 Work distribution throughout the nine months on site.

4.1.4 Discussion with Svensk Bygglogistik AB

In consultation with Svensk Bygglogistik AB regarding the issues identified in *Company A,* these issues occurred even though *Company A* has an internal logistic manager, because internal logistics managers in construction companies are commonly overwhelmed by on site operative construction issues, which gives them the difficulty to fully dedicate their time in being involved in the strategic decisions and alignment with procurement department. It is obvious that the Project is a large and rather complicated project with plenty of work phases, which requires three levels of hierarchy as shown in Figure 2. Therefore, the logistics manager can dedicate the time to focus on strategy and the logistics operative engineers can focus on the operation and maintenance of the plan.

The logistics manager should be involved at the early stage so that the procurement process is also coordinated properly for procuring the right deliverable, with the right price, including the logistics plan considerations.

Should Svensk Bygglogistik AB be assigned to the Project from the initial phase, one logistics manager would be working with the construction manager at the very start, to deal with procurement, construction site management and logistics management. Before the construction works commence, the logistics manager would visit the site and gather data to investigate the logistics planning for the early stage of work. This is when the *Arbetsplatsdispositionsplan* (APD-plan) is produced. Although in the initial phase of the construction process there are not many laborers on the site. There are on the other hand resources on site that need to be taken care of, therefore logistics planning is essential. The logistics manager continues to update the APD-plan on a weekly basis to adjust to the condition of the site.

Regarding case 2, the solution would be that the logistics manager overlooked the problem from six months before. As the logistics manager would be involved at the early stage, that procurement process would be coordinated properly to be delivered at the right time, to the right place, at the right price. At this initial phase, the purchase group would also have been notified about the situation on site, which would require them to adjust to the situation on site. Coordination with the stakeholders would be mediated by the digital platform *LogNet.* This software is used for coordination with all the subcontractors, especially on site, which can be used as a check list point to make sure that everyone has the information immediately.

The planning and operative logistics team will be assigned on site from month three to implement the logistics coordination on site that was planned by the logistics manager to be realized.

Logistics has been seen as something that is insignificant and simple that has been overlooked by most people in the construction industry. Yet, construction managers realize this most times in the middle of the project and realize that a dedicated logistics management team is required. So, they end up assigning a TPL provider in the middle of the project to solve their current logistics problems. This is one of the challenges that companies such as Svensk Bygglogistik AB has to

encounter, especially that logistic is ideally handled in a more strategic manner rather than an operative way.

4.2 Literature and Empirical Data (Interview & Survey) Analysis and Discussion

4.2.1 Efficiency

The literature shows the significance of integrating a dedicated logistics management team within construction sites in terms of efficiency. It is also stated that strategic planning overseen by dedicated professionals is deemed crucial in ensuring timely deliveries and efficient offloading procedures, resulting to increasing project efficiency. Studies suggest that proper logistics management mitigates inefficiencies and cost escalation, especially in waste management. In addition, the integration of dedicated logistics teams equipped with specialized skills and expertise is highlighted as fundamental in optimizing material flow and reducing unproductive labor time.

The empirical data gives practical experiences into the implications of dedicated logistics management teams in construction projects. which correlates findings from the literature review. Interviews with industry professionals underline the significance of proper logistics planning in ensuring project efficiency. Engaging dedicated logistics teams enables better control, communication, and coordination, thereby facilitating smooth project execution and minimizing delays. It also increases the possibilities of engaging long-term relationships with suppliers as well as local suppliers to enhance sustainability, efficiency and quality of the project. Moreover, the interviews highlight the importance of strategic planning from the early stages of construction projects. Enhanced communication between systems and stakeholders is emphasized as essential for optimizing logistic flows and minimizing downtime. In addition, all the professionals who participated in the survey also aligns with the literature review signifying that engaging dedicated logistics teams prevents undue delays to the time for completion of the project and it affects the overall of the project positively.

Both the literature and empirical data underlines the significant role of dedicated logistics management teams in enhancing efficiency within construction projects. Strategic planning, resource optimization, and effective communication emerge as

key factors underpinning the success of logistics management initiatives, highlighting the importance of integrating these practices into construction project workflows.

4.2.2 Cost-Effectiveness

The analysis of cost-effectiveness in construction logistics, as studied through and derived from the interviews, survey results, and literature review, highlights a multifaceted approach to optimizing costs.

The literature review highlighted the cost-effectiveness by having a dedicated logistics team. Various perspectives from literature, which support this correlation, have been analyzed with the findings of the empirical data collected throughout the semi-structured interviews and survey conducted for the purposes of this research. Both the literature review and the data retrieved from the empirical study under this research provided valuable insights into how cost-effectiveness is ensured. This section discusses the similarities and differences between the literature review and the empirical findings.

Sullivan et al. (2010) stressed that the deployment of specialized logistics professionals is beneficial to mitigate the risks and hence avoid unexpected costs. The presence of such specialized logistics professionals can help organizations to identify the potential risks and ensure the ability to effectively handle those by efficient planning.

Efficient planning reduces costs associated with undue activities. Linden and Josephson (2013) suggested a potential cost reduction of approximately twenty percent of the indirect costs through effective logistics management. The lack of dedicated and specialized logistics professionals leads to insufficient logistics planning and consequently disruptions in the works, resulting in decreased productivity, delays, and eventually and unavoidably additional costs. The costs associated with the construction logistics are analyzed by Fang and Ng (2011) and they have classified those in four categories of resource consumption: (i) during

storage, (ii) during transportation, (iii) during loading, and on-site storage, and (iv) in purchasing. This categorization is essential to provide insights into the cost driving activities and potential opportunities to optimize.

On the other hand, the interviews provided practical insights upon the concepts discussed in the literature review, where it was addressed that the cost-effectiveness in the construction industry can be enhanced through strategic approaches, particularly with the involvement of a dedicated logistics team. A dedicated logistics team can also assist in managing the complex procurement issues.

The empirical data result also showed that efficient logistics management can have a direct impact on the project cost, and a dedicated logistics team can assist to prevent undue costs by managing the supply chain effectively. Proper organization of the logistics can also assist with reduced waste, leading to increased margins.

Survey findings reinforce these insights, indicating that a significant portion of respondents (68%; 36 out of 53) have expressed their experience with a dedicated logistics team. Of these, half have done it by outsourced TPL providers, and the other half by their in-house teams. This diverse experience suggests broad applicability of dedicated logistics teams in various organizational contexts. Furthermore, 94% of those who worked with TPL providers found it beneficial, underscoring the effectiveness of dedicated logistics teams in reducing costs and improving efficiency.

Another major theme addressed in the interview findings is that having a dedicated logistics team involved in the early or strategic phase of a project prevents unexpected costs due to delays, waste, and damaged materials. Early investment could prevent projects incurring undue additional costs, which tend to add up more than the initial investment amount. Further reference is made to the long-term relationships with the suppliers, where the suppliers collaborate better and offer solutions and ideas to improve efficiency, which eventually offers increased cost-effectiveness.

Furthermore, findings from the interviews suggested that there is a threshold, which is reportedly around SEK 200 million, with reservations on the nature, type, location, and the purpose of the project, being decisive to benefit from deploying a dedicated logistics team. Some interviewees highlighted that working with a dedicated team, hence planning better in the logistics solutions could have identified significant savings although initial investment costs seem to be high.

The survey also revealed that a significant majority of respondents (85%; 45 out of 53) have encountered cost overruns due to logistics management issues. This finding points out the importance of efficiency in logistics management, as highlighted in both the literature and interviews. The respondents' perception that dedicated logistics teams positively impact overall efficiency, time, and cost further aligns with the insights from the literature and interviews.

Both literature review and empirical findings from the interviews and survey touch on the critical role of having a dedicated logistics team for mitigating risks, avoiding undue costs, hence enhancing the cost-effectiveness. Furthermore, the literature and the empirical studies align on the importance of involvement of logistics teams in the early stages of the project to take strategic decisions for the optimization of the resources and maintaining risks in a controllable level. Another similarity between the literature and the empirical findings is that both recognize the benefits of strategic approach of having long-term relationships to collaborate in a manner to enhance cost-effectiveness.

Whilst the research identified differences, these differences do not necessarily oppose each other. Accordingly, those are not qualified as an outcome of this analysis.

Both the literature review and the empirical findings strongly support the cost-effectiveness of dedicated logistics management. They complement each other by providing theoretical frameworks and practical perspectives. The deployment of

dedicated logistics teams fosters strategic resolutions and highly qualified planning efforts which optimizes project outcomes, particularly reduced costs.

4.2.3 Challenges and Best Practices

Analyzing the information from both the literature review and interviews provides valuable insights into the details and effective strategies within construction logistics, particularly concerning TPL providers and dedicated logistics management teams. Both literature review and interviews highlight the complex nature of construction projects, characterized by their temporary nature, involvement of several stakeholders, and the necessity to comply with various regulations and contract standards. Because of this, integrating TPL providers into construction processes requires careful direction finding and strategic planning.

Effective communication develops as a principal theme across both the literature review and interviews. Clear and efficient communication among the logistics team, contractors, suppliers, and other stakeholders is identified as critical for overcoming complications and ensuring the success of construction projects. Additionally, the significance of dedicated logistics management teams is highlighted in both sources. Dedicated logistic teams play an essential role in enhancing project efficiency, coordination, and communication, thereby mitigating risks, minimizing delays, and ultimately improving project outcomes.

While both the literature, survey, and interviews recognize the importance of logistics management in construction projects, there are nuanced differences in perspectives regarding challenges, best practices, and the level of industry recognition. Bridging these gaps and addressing practical barriers, such as supplier relationships and union issues, is crucial for optimizing logistics processes and improving project outcomes in the construction industry.

By reflecting on the literature and interviews, it becomes clear that overcoming the challenges mentioned requires a strategic approach e.g. dedicated to specialized logistics teams can enhance efficiency by ensuring that materials and equipment

are handled correctly and delivered on time. This approach minimizes risks such as material unavailability and damage, ultimately leading to better project outcomes. Strategic planning, including early involvement of logistics teams and establishing strong partnerships with TPL providers, is crucial for aligning logistics with project goals.

When considering technology, GPS tracking and real-time monitoring can significantly improve logistics performance by enhancing visibility and control over the supply chain. This technological integration supports continuous improvement and helps construction companies adapt to changing conditions more effectively. By following regulations and measuring performance using key performance indicators (KPIs) supports that TPL arrangements meet industry standards and positively impact project success.

5 Conclusion

From our research, we conclude that the role of dedicated logistics management team enhances construction project outcomes as it ensures the interconnected flows of Information, material, as well as flow of human resource. Communication is key and with the presence of the construction logistics management team on site, effective communication and collaboration following the establishment of a logistics plan to assure that all stakeholders are aligned would be ensured.

The research and interviews with industry professionals clearly demonstrate that the implementation of a dedicated logistics management team significantly improves project efficiency and reduces costs. The main challenge in the research was to analyze the justification of the additional expenditure on a dedicated logistics management team, where the findings confirm that this investment mitigates the risk of cost overruns and inefficiencies, which often prove to be far more expensive than the cost of a logistics team.

By making most construction professionals aware of the importance of the role of dedicated logistics management teams and recognizing their existence as a critical component of construction project management, stakeholders can eliminate many of the inefficiencies that is manifested in the current practices. The evidence presented in this thesis guides a path to a paradigm shift in how logistics management is perceived and implemented, suggested that a dedicated management team is not only an added cost, but also a strategic investment that increases project efficiency and cost effectiveness.

5.1 Limitation

Regional limitation (mostly in Sweden) and not having apple to apple projects to be able to compare. Not having access to a project that Svensk Bygglogistik AB suggested to analyze due to certain circumstances at the time of the research, lead us to not being able to analyze the project in the view of efficiency and analyzing

the challenges and best practices of the site, therefore the project analysis was limited to cost analysis.

5.2 Future Recommendations

Enhance information flow:

Enhancing data flow with technologies like LogNet and AI (Artificial Intelligence) for Realtime data collection and timely and accurate information ensures a smooth workflow. By deploying supply chains with the technology of ERP (Enterprise Resources Planning) as well as TMS (Transportation Management System) into a single system, the integrity and flow of information will be developed, allowing reduction in time between transactions.

Early Involvement

When considering early involvement with logistic management in the construction industry, it is highly recommended to engage all stakeholders in the early and pre-contract stages. Thus, in the early stage it is easy to plan and make a decision process so that all the stakeholders' needs and expectations are met. This will support to lead better logistic coordination and problem solving.

Increase Awareness

To increase awareness in logistic management it is important to develop training programs and CPD programs within stakeholders and employees in the construction industry. So, from these methods people can be aware of the latest trends and best practices which should be applied to construction logistic management and improve performance. It is also significant to increase awareness of the younger generation who are entering the construction industry how logistics management within the industry.

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7 APPENDICES

7.1 Job Description – Logistics Manager

BYGG
LOGISTIK

Generell Arbetsbeskrivning

ARBETSGIVARE

Företag Svensk Bygglogistik AB	
Utfärdare (titel): HR-chef	
Skapad datum 240213	Uppdaterad datum

UPPGIFTER OM BEFATTNINGEN

Befattning / Titel:	Logistikansvarig
Gäller för medarbetare:	
Rapporterar till (titel):	Projektchef
Attesterande chef om annan än ovan (titel):	
Tjänstens omfattning:	Driver strategiska och operativa logistikfrågor i större byggprojekt.

BEFATTNINGENS ÖVERGRIPANDE SYFTE OCH MÅL

Logistikansvarig förvaltar och driver projektet/byggområdets logistikplan. Målsättningen är att minimera hinder och skapa en planerad produktion med hög effektivitet.

NORMALT FÖREKOMMANDE ARBETSUPPGIFTER FÖR BEFATTNINGEN

- Upprätta och förvalta projektets logistikplan (logistiska flöden, regler och rutiner för leverantörer och entreprenörer) och säkerställa att dessa efterlevs genom hela projektet. *Med stöd från teknisk konsult.*
- Arbetsleda projektets övriga logistikpersonal såsom ex: Leveransplanerare och Leveransmottagare i det dagliga arbetet.
- Upprätta och förvalta APD-planer. *Med stöd från teknisk konsult.*
- Kalla till och leda veckovisa logistikmöten och informationsmöten med entreprenörer/leverantörer.
- Hålla i APD-plansamordningsmöten, med berörda aktörer.
- Delta i produktionsmöten och eventuella projekteringsmöten.
- Samordning och löpande kontakt med berörda myndigheter, beställare och övriga parter.
- Driva logistikstrukturen i projektets leveransplaneringssystem "LogNet" eller likvärdigt logistiksystem. (*Logistikplanerare administrerar LogNet i drift*)
- Arbeta med avvikelsedokumentation avvikelser utifrån projektets logistikplan och uppföljning av dessa.
- Arbeta med framtagning och förvaltning av arbetsrutiner och instruktioner.
- Sammanställa statistik avseende logistikflöden som verktyg för uppföljning och styrning.

PRIORITERINGSORDNING AV ARBETSUPPGIFTER

- Förvalta och säkerställa projektets logistikplan genom hela projektet.
- Kalla till och leda logistikmöten och informationsmöten med entreprenörer/leverantörer
- Arbetsleda projektets övriga logistikpersonal såsom ex: Leveransplanerare och Leveransmottagare i det dagliga arbetet.
- Samordning och löpande kontakt med berörda myndigheter, beställare och övriga parter.

STÖD FÖR ATT UTFÖRA ARBETE

Projektchef Svensk Bygglogistik AB
HR-Chef Svensk Bygglogistik AB

AVGRÄNSNINGAR

Beställaren ansvarar för produktionsledning. Beställaren ansvarar och är avtalspart för de entreprenörer/resurser som verkar på projektet, Svensk Bygglogistik AB stödjer Beställaren i logistikstyrning av de entreprenörer/resurser som verkar på området.

ÖVRIGA UPPLYSNINGAR

7.2 Job Description – Logistics Planner

BYGG LOGISTIK

Generell Arbetsbeskrivning

ARBETSGIVARE

Företag Svensk Bygglogistik AB	
Utfärdare (titel): HR-chef	
Skapad datum 240213	Uppdaterad datum

UPPGIFTER OM BEFATTNINGEN

Befattning / Titel:	Leveransplanerare
Gäller för medarbetare:	
Rapporterar till (titel):	Projektchef
Attesterande chef om annan än ovan (titel):	
Tjänstens omfattning:	Utför samordnande operativa logistikuppgifter i större byggprojekt

BEFATTNINGENS ÖVERGRIPANDE SYFTE OCH MÅL

Leveransplanerare säkerställer den dagliga logistikplaneringen för byggprojektet/byggområdet. Målsättningen är att minimera hinder och skapa en planerad produktion med hög effektivitet.

NORMALT FÖREKOMMANDE ARBETSUPPGIFTER FÖR BEFATTNINGEN

- Huvudadministratör för projektets leveransplaneringssystem "LogNet" eller likvärdigt logistiksystem. (Resursplanering, granskning av leveransbokningar, behörighet för nya användare, uppdatering av nyhetssida och/eller startsida)
- Samordning av transportvägar, upplagsytor och lossningsplatser utifrån planering i leveransplaneringssystmet.
- Samordning och förvaltning av APD-förändringar, om inte Logistikansvarig finns.
- Medverka på projektets logistikmöten.
- Göra arbetsberedningar och göra överlämning till intransport (till Svensk Bygglogistiks eller till annan part).
- Upprätta och förvalta invändiga placeringsritningar.
- Planering och avrop av lossningsresurser.
- Avsyning av transportvägar och materialplaceringar för leveranser.
- Kontaktperson och samordnare mot byggavfallsentreprenör och sammanställning av avfallsstatistik.
- Fraktions- och mängdplanering av avfall (containrar och kärl).
- Ansvarig för uppföljning av intransport.
- Andra arbetsuppgifter kan tillkomma.

PRIORITERINGSORDNING AV ARBETSUPPGIFTER

- Administrera projektets leveransplaneringssystem "LogNet" eller likvärdigt logistiksystem
- Göra arbetsberedningar, invändiga APD-planer/placeringsritningar och överlämningar till intransport
- Planering och avrop av lossningsresurser.
- Samordning av byggavfallsentreprenör.

STÖD FÖR ATT UTFÖRA ARBETE

Projektchef Svensk Bygglogistik AB
HR-Chef Svensk Bygglogistik AB

AVGRÄNSNINGAR

Beställaren ansvarar för produktionsledning. Beställaren ansvarar och är avtalspart för de entreprenörer/resurser som verkar på projektet, Svensk Bygglogistik AB stödjer Beställaren i logistikstyrning av de entreprenörer/resurser som verkar på området.

ÖVRIGA UPPLYSNINGAR

7.3 Survey Questions

1. Which country are you working right now? *

Enter your answer

2. Choose the option that describes your organisation. *

- ◯ Client / Employer
- ◯ Contractor
- ◯ Consultant
- ◯ Other

3. Which one of the following reflects your role in the organisation? *

- ◯ Logistics
- ◯ Commercial & Contracts
- ◯ Project Management
- ◯ Cost Control / Quantity Surveying
- ◯ Construction Management / Site Supervision
- ◯ Scheduling / Planning
- ◯ Other

4. What is the total experience you have in the construction industry? *

- ◯ 1-2 years
- ◯ 2-5 years
- ◯ 5-10 years
- ◯ More than 10 years

5. Do you have a dedicated team in your company who specifically only manages construction logistics (*material handling from supplier to site and how the materials are distributed on site, site cleaning, provision of amenities, planning equipment and vehicle movement on site (e.g. crane position and trucks)*) on site? *

- ◯ Yes
- ◯ No
- ◯ Other

6. Have your company outsourced a third-party dedicated construction logistic team? *

- ◯ Yes
- ◯ No
- ◯ Other

7. If YES, can you reflect your experience with them?

- ◯ Very Beneficial
- ◯ Somewhat Beneficial
- ◯ Neutral
- ◯ Not Beneficial
- ◯ Just Another Cost
- ◯ Have not worked with them directly

8. Have you ever experienced cost overruns due to logistics management issues? *

- ◯ Yes
- ◯ No
- ◯ Other

9. Please provide your reflection on below statements on having a dedicated logistics team: *

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
It affects the overall efficiency of the project positively	◯	◯	◯	◯	◯	◯
It saves significant cost in the project	◯	◯	◯	◯	◯	◯
It prevents undue delays to the time for completion of the project	◯	◯	◯	◯	◯	◯