Construction supply chains in complex environments

A case study of construction logistics coordination in a hospital expansion project

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Abstract

Title: Construction supply chains in complex environments
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Background:
Construction projects in dense urban and operational environments place high demands on logistics integration, planning, and material flow management. Increased project complexity, limited site space, and ongoing surrounding operations create major delivery challenges in construction projects. These challenges include limited storage capacity, transportation difficulties, and the need for coordination between multiple actors in the construction supply chain. At the same time, the construction industry continues to face efficiency challenges and fragmented supply chain structures, highlighting the importance of structured logistics solutions and integrated supply chain management.

Purpose and research questions:
The purpose of this thesis is to analyse and evaluate how construction logistics is planned and coordinated, and to assess to what extent logistics solutions reduce disruptions in the construction process. The study examines how construction logistics practices can support coordination, material flow management, and risk reduction in complex construction environments.

Theoretical foundation and methodology:
The study is based on theories within construction logistics, construction supply chain management, lean construction, procurement strategies, and supply chain risk management. Particular emphasis is placed on coordination mechanisms, logistics planning, procurement structures, and material flow management in project-based supply chains.

The thesis was conducted as a qualitative single case study of the “Tillbyggnad Lund” (TBL) project at Lund University Hospital. The study follows an interpretivist and abductive research approach and combines empirical data from semi-structured interviews, project documentation, and observations. Interviews were conducted with key actors involved in the logistics system, including the general contractor, a third-party logistics provider, and a digital delivery management system provider. The empirical findings were analysed in relation to theories within construction logistics, supply chain management, lean construction, and supply chain risk management.

Result and Analysis:
The findings show that construction logistics in complex environments require extensive coordination, structured planning, and integration between multiple actors within the supply chain. The study shows that logistics solutions such as construction logistics plans, digital delivery management systems, logistics checkpoints, and third-party logistics providers contribute to improved delivery precision, reduced congestion, and enhanced control of material flows.

The analysis indicates that early logistics involvement and continuous communication between stakeholders are essential for managing constraints related to limited site space, ongoing hospital operations, and complex delivery structures. Furthermore, the findings indicate that procurement structures and collaborative project arrangements significantly influence the implementation and performance of construction logistics systems. At the same time, the implementation of structured logistics systems introduces additional coordination requirements and dependencies between actors, emphasizing the importance of clearly defined responsibilities and integrated planning processes.

Conclusion:
The study concludes that construction logistics should be treated as an integrated and strategic component of project planning rather than as a supporting operational function. Structured logistics systems and coordinated supply chain management can improve efficiency, reduce disruptions, and enhance predictability in complex construction environments. However, successful implementation depends on early planning, collaboration between actors, and the ability to integrate logistics activities with on-site production and surrounding operations.

Keywords:
Construction Logistics, Integrated Logistics Solutions, Third-Party Logistics, Construction Consolidation Centre, Hospital Construction

Sammanfattning

Titel: Bygglogistik i komplexa miljöer
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Bakgrund:
Byggprojekt i täta, urbana och aktiva miljöer ställer höga krav på logistisk koordinering, planering och hantering av materialflöden. Ökad projektkomplexitet, begränsade ytor på byggarbetsplatsen och pågående verksamheter i omgivningen skapar stora utmaningar för leveranser i byggprojekt. Dessa utmaningar inkluderar begränsad lagringskapacitet, transportrelaterade svårigheter samt behovet av koordinering mellan flera aktörer inom byggprojektets försörjningskedja. Samtidigt fortsätter byggbranschen att möta effektivitetsutmaningar och fragmenterade försörjningskedjor, vilket belyser vikten av strukturerade logistiklösningar och integrerad supply chain management.

Syfte och frågeställningar:
Syftet med denna studie är att analysera och utvärdera hur bygglogistik planeras och koordineras, samt att undersöka i vilken utsträckning logistiklösningar bidrar till minskade störningar i byggprocessen. Studien undersöker hur olika arbetssätt och inom bygglogistik kan stödja koordinering, hantering av materialflöden och riskreducering i komplexa byggmiljöer.

Teori och metod:
Studien bygger på teorier inom bygglogistik, construction supply chain management, lean construction, upphandlingsstrategier och supply chain risk management. Särskilt fokus läggs på koordinationsmekanismer, logistikplanering, upphandlingsstrukturer och hantering av materialflöden i projektbaserade försörjningskedjor.

Studien genomfördes som en kvalitativ enfallsstudie av projektet Tillbyggnad Lund vid Lunds universitetssjukhus. Studien utgår från ett interpretivistiskt och abduktivt forskningsperspektiv och kombinerar empiriskt material från semistrukturerade intervjuer, projektdokumentation och observationer. Intervjuer genomfördes med centrala aktörer involverade i logistiksystemet, inklusive huvudentreprenören, en tredjepartslogistikleverantör samt en leverantör av ett digitalt leveranshanteringssystem. Det empiriska materialet analyserades i relation till teorier inom bygglogistik, supply chain management, lean construction och supply chain risk management.

Resultat och analys:
Resultaten visar att bygglogistik i komplexa miljöer kräver omfattande koordinering, strukturerad planering och integration mellan flera aktörer inom försörjningskedjan. Studien

visar att logistiklösningar såsom bygglogistikplaner, digitala leveranshanteringssystem, logistiska checkpoints och tredjepartslogistikleverantörer bidrar till förbättrad leveransprecision, minskad trängsel och förbättrad koordinering av materialflöden.

Analysen visar att tidig involvering av logistik samt kontinuerlig kommunikation mellan projektets intressenter är avgörande för att hantera begränsningar relaterade till begränsade arbetsytor, pågående sjukhusverksamhet och komplexa leveransstrukturer. Vidare visar resultaten att upphandlingsstrukturer och samverkansbaserade projektupplägg har en betydande påverkan på implementeringen och prestationen hos bygglogistiksystem. Samtidigt innebär implementeringen av strukturerade logistiksystem ökade krav på koordinering och beroenden mellan aktörer, vilket understryker vikten av tydligt definierade ansvarsområden och integrerade planeringsprocesser.

Slutsatser:
Studien drar slutsatsen att bygglogistik bör behandlas som en integrerad och strategisk del av projektplaneringen snarare än som en stödjande operativ funktion. Strukturerade logistiksystem och koordinerad supply chain management kan förbättra effektivitet, minska störningar och öka förutsägbarheten i komplexa byggmiljöer. En framgångsrik implementering är dock beroende av tidig planering, samarbete mellan aktörer samt förmågan att integrera logistikaktiviteter med produktionen på byggarbetsplatsen och den omgivande verksamheten.

Nyckelord:
Bygglogistik, Integrerade logistiklösningar, Tredjepartslogistik, bygglogistikcenter, Sjukhusbyggprojekt

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1. Introduction

This chapter introduces the thesis project by presenting the background and problem formulation, in addition to its stated purpose. The introduction also presents the stipulated research questions, case introduction and project delimitations.

1.1 Background

In recent decades, the construction industry has faced increasing pressure to improve efficiency, integration, and project performance while simultaneously managing growing project complexity. In Sweden, construction projects are increasingly carried out in dense urban environments and around critical societal infrastructure (Ljungberg et al., 2012). At the same time, the Swedish construction sector has experienced economic pressure in recent years, characterized by rising costs, reduced investment levels, and lower construction activity in several market segments (Byggföretagen, 2025). These developments place increasing demands on coordination, planning, and logistics management within construction projects. Construction in constrained and operational environments often involves complex delivery structures, limited storage possibilities, and extensive coordination between multiple actors and activities (Sullivan et al., 2010). As a result, inefficiencies in logistics planning and material flow management may lead to disruptions, delays, increased costs, and reduced productivity on site. Consequently, systematic construction logistics and integrated supply chain management have become increasingly important for improving project performance and managing complexity in modern construction projects.

Both research and industry reports emphasise that improved construction logistics can contribute to higher productivity, reduced waste, and improved on-site efficiency (McKinsey Global Institute, 2017; Josephson & Saukkoriipi, 2005). Despite this potential, the construction industry has been slow to adopt more integrated and innovative logistics solutions (Sullivan et al., 2010). Construction logistics plays a central role in the performance of construction projects, particularly in complex and space-constrained environments. Ekeskär & Rudberg (2016) writes that construction projects are characterized by fragmented supply chains, multiple actors, and temporary organizational structures. Which makes management of transport, deliveries, and material flows challenging. These challenges are further increased in projects where logistics solutions such as third-party logistics providers, external terminals, or consolidation centers are introduced, as they may shift costs and responsibilities across the supply chain (Thunberg & Fredriksson, 2023).

Furthermore, studies highlight that insufficient coordination of transport logistics can lead to inefficiencies, disturbances, and increased risk in construction operations (Peiris et al., 2023).

Hospital construction projects represent a particularly demanding context, if the construction takes place alongside ongoing operations. In such environments, logistics must account for limited space, strict safety requirements, and the need to avoid disruptions to patient care and critical hospital functions (Ekeskär & Rudberg, 2016). This increases the need for extensive planning and collaboration, which makes reliable and organized logistics solutions essential to maintain efficiency, safety, and continuity of healthcare services.

Research highlights that the implementation of logistics solutions such as delivery management systems, consolidation centres, checkpoints, and third-party logistics providers has increased in construction projects (Fredriksson et al., 2024). At the same time, studies continue to identify challenges related to coordination, integration, and responsibility distribution within construction supply chains (Thunberg & Fredriksson, 2023). While previous studies have demonstrated the potential benefits of construction logistics, less attention has been directed towards how different logistics functions interact as integrated systems within complex project environments. This becomes particularly relevant in projects carried out alongside ongoing operations, where logistics activities must be managed not only within the project itself, but also in relation to surrounding functions and external stakeholders.

Despite growing awareness of the importance of construction logistics, research indicates that challenges related to cost distribution, transport management, and interdependencies between actors remain significant, especially when implementing more advanced logistics setups (Thunberg & Fredriksson, 2023; Peiris et al., 2023). This indicates a need for further investigation into how integrated construction logistics systems are planned, managed, and implemented in complex project environments. Furthermore, there is a need to better understand how such systems can support efficiency, coordination, and risk reduction while managing operational constraints and dependencies between actors.

1.2 Purpose

The purpose of this thesis is to analyze and evaluate how construction logistics is planned and coordinated in construction projects. Furthermore, the study aims to assess how integrated logistics solutions contribute to coordination in the construction process.

1.3 Research questions

The following research questions have been formulated to fulfill the purpose and will constitute the foundation of the thesis project.

RQ1: "*How can construction logistics be planned and implemented to reduce disruptions in construction projects?"*

RQ2: "*How are constraints managed in the development and execution of construction logistics practices?"*

RQ3: "*How do logistics solutions and their integration support the coordination of material flows in complex construction environments?*"

1.4 Delimitations

The thesis is limited to a qualitative single case study of the "Tillbyggnad Lund" (TBL) project in Lund, a town in southern Sweden. The focus is on the planning and practical application of the construction logistics setup. The study primarily examines logistics processes related to inbound and outbound material flows, coordination mechanisms, and logistics governance, including the use of external terminals and digital delivery planning systems.

The study does not include quantitative performance measurements or financial evaluations of logistics efficiency. Furthermore, the analysis is limited to the perspectives of selected key actors involved in the logistics system and does not include a broader analysis of legal procurement frameworks or environmental sustainability impacts.

1.5 Report outline

Chapter 1: Introduction
Introduces the thesis by outlining the background and context, problem formulation, purpose, and research questions. It defines and explains the scope of the study, including its delimitations.

Chapter 2: Theoretical Foundation
The theoretical foundation presents relevant research and key theories related to the subject, aiming to provide the reader with a sufficient theoretical background. Together with the empirical findings, the theoretical framework forms the basis for the analysis.

Chapter 3: Methodology
Outlines the research design, approach and introduces the case study. It describes the data collection methods, and analysis techniques used to ensure the validity and reliability of the study.

Chapter 4: Empirical findings
The empirical findings summarize the insights gathered from interviews with industry professionals, as well as from documentation reviewed and observations made within the case study.

Chapter 5: Analysis
The analysis presents a comparison between the theoretical framework and the collected empirical data. The purpose is to interpret the findings in relation to the research questions and identify similarities, differences, and patterns between the theoretical perspectives and the empirical results.

Chapter 6: Conclusion
The final chapter provides the conclusions to the research questions. It also provides recommendations for the project and its actors in order to improve logistics together with further areas of research.

2. Theoretical foundation

This chapter presents the theoretical framework underlying the study by outlining key concepts related to construction logistics and material flow management. The chapter defines central aspects of the construction logistics process. Relevant theories and models related to logistics efficiency, coordination, and risk management are introduced to provide a foundation for the subsequent analysis of the case study. A holistic overview of the theoretical foundation and the given relations between the key concepts is provided by figure 2.1

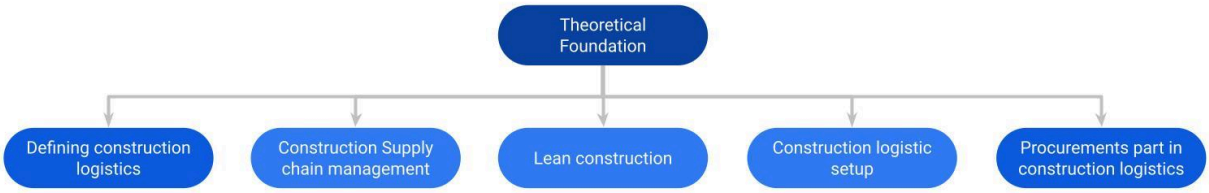

Figure 2.1: Illustration of the theoretical foundation

2.1 Defining construction logistics

Construction logistics refers to the planning, coordination, and control of material, equipment, and information flows to and within construction sites, in order to support efficient production and minimize disruptions (Vrijhoef & Koskela, 2000; Sullivan et al., 2010). This includes both on-site and off-site activities. Off-site logistics includes all activities occurring before and after the construction site, such as the transportation of materials and resources to and from the site (Fredriksson et al., 2024). On-site refers to everything inside the construction site, with typical activities such as delivery handling, on-site storage and distribution and waste management (Ying et al., 2018).

Despite its importance, construction logistics has historically received limited attention within the construction industry. The construction industry is often described as less innovative and slower to adopt new processes compared to other industries, which has contributed to persistent inefficiencies in project execution and supply chain management (Vrijhoef & Koskela, 2000; Persson et al., 2010). Construction projects are typically characterised by temporary organisational structures, multiple interacting actors, and a high degree of variability, which together increase complexity. Unlike manufacturing, construction activities are largely project-based, with materials, resources, and actors continuously entering and leaving the production system.

A defining feature of construction logistics is the project-specific nature of supply chains. Each project is carried out in a unique physical and organisational context, often resulting in complex coordination requirements between contractors, subcontractors, suppliers, and logistics service providers (Sobotka & Czarnigowska, 2005; Fernández-Solís, 2008). These challenges are influenced by factors such as site conditions, surrounding environments, regulatory constraints, and the number of parallel activities that must be managed simultaneously (Wegelius-Lehtonen, 2001; Ekeskär & Rudberg, 2016). As projects become more complex and time-constrained, the importance of effective coordination of logistics activities increases (Koskela et al., 2002).

2.1.1 Traditional approach to construction logistics

Traditionally, construction projects have been planned and managed with a strong focus on on-site production, where logistics activities are treated as supportive rather than strategic processes. Planning approaches such as work breakdown structures and critical path methods are commonly used to structure project activities, but often assume smooth handovers between tasks and stable material flows (Koskela et al., 2002). In practice, late design changes, delivery disturbances, and resource constraints frequently disrupt these assumptions, leading to waiting time, rework, and inefficiencies (Dubois & Gadde, 2002b).

As highlighted by Sullivan et al. (2010), construction logistics has traditionally been treated as a series of isolated activities rather than as an integrated process spanning the entire project. Deliveries, material handling, and transport activities are often managed independently by different actors, resulting in disjointed and reactive coordination processes. As illustrated in Figure 2.2, this may lead to uncontrolled material flows, inefficient resource utilization, congestion, disruptions to surrounding environments, and increased waste generation. The figure further demonstrates how limited coordination and lack of integrated logistics planning can create both operational inefficiencies on site and negative impacts on surrounding urban environments.

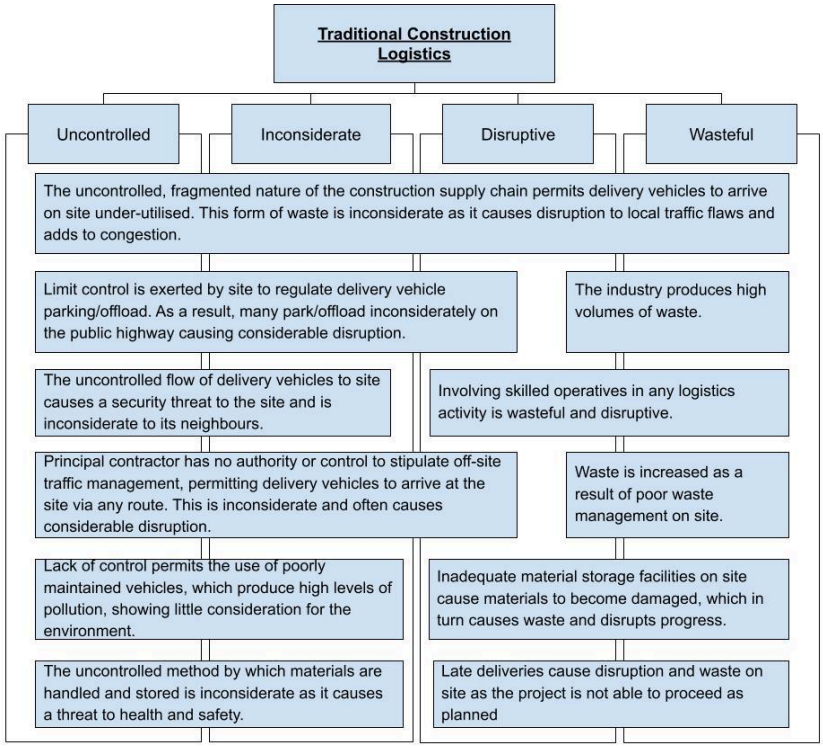

Figure 2.2: Issues in traditional construction logistics (Adapted from Sullivan et al., 2010)

2.1.2 Developments in construction logistics

Recent developments in urban planning have further intensified the challenges associated with construction logistics. The densification of cities has resulted in construction projects being carried out in increasingly space-constrained and sensitive environments, where access, transport routes, and on-site storage capacity are limited (Mattson, 2015; Ekeskär & Rudberg, 2016). These conditions reduce the feasibility of traditional logistics practices, where materials are delivered directly to site and stored until needed. In such contexts, construction logistics becomes a critical factor for project performance, as poorly planned deliveries can lead to congestion, safety risks, and disruptions both on site and in surrounding urban areas (Sullivan et al., 2010). As a result, increased attention has been directed towards improving the planning, coordination, and control of material flows in construction projects.

In response to these challenges, several developments in construction logistics have emerged. One key development is the increasing use of structured logistics solutions, such as third-party logistics providers, consolidation centres, and dedicated site logistics management (Sullivan et al., 2010; Hamzeh et al., 2007). These approaches aim to centralise and plan material flows, reduce on-site congestion, and improve the reliability of deliveries.

Additionally, the adoption of digital tools and delivery management systems has enabled improved visibility and coordination of logistics processes. By introducing systems for delivery booking, tracking, and information sharing, construction projects can better manage material flows and reduce variability in site operations (Seppänen & Peltokorpi, 2016). These developments reflect a broader shift towards integrating logistics into project planning rather than treating it as a reactive support function. However, despite these advancements, the development of construction logistics has been relatively slow. While several studies demonstrate that structured logistics solutions can significantly improve project performance, these practices are often implemented on a project-specific basis rather than adopted systematically across the industry (Vrijhoef & Koskela, 2000; Dubois & Gadde, 2002b).

2.2 Construction Supply chain management

Supply Chain Management (SCM) has become a critical factor in achieving competitive advantage in the marketplace. Stadtler (2000) defines SCM as "The task of integrating organizational units along a supply chain and coordinating material, information and financial flows in order to fulfill the (ultimate) customer demands." Building on this, Persson et al. (2010) suggest that construction SCM can be defined as "The task of integrating organizational units along a supply chain, including the construction site and subcontractors, and coordinating materials, information and financial flows with the project site plan in order to fulfill the customer demands." Within the construction industry, Vrijhoef and Koskela (2000) identify four distinct roles associated with construction supply chain management. These roles vary depending on whether the primary focus is on the supply chain, the construction site, or an integration of both.

The first role focuses on improving site efficiency by ensuring the reliable availability of materials and labour in order to avoid disruptions in on-site production. This perspective is typically adopted by contractors and emphasises efficient site operations. The second role extends beyond the construction site and aims to reduce costs across the entire supply chain. This includes transportation costs, lead times, inventory levels, and other logistics-related expenses.This broader perspective is more commonly associated with suppliers. The third role seeks to transfer certain on-site activities upstream within the supply chain to reduce interference and congestion at the construction site. However, due to the interdependent nature of on-site activities, implementing this approach has historically been challenging in the construction sector. Both contractors and suppliers may take the initiative in adopting this role. The fourth and final role emphasizes integrated management and promotes a holistic perspective of the entire supply chain. Rather than viewing the construction site as a separate, final phase, it is regarded as an integral component of the supply chain. This comprehensive approach may be initiated by clients, contractors, or suppliers and aims to strengthen coordination and overall performance.

Subsequent research has extended the framework by addressing limitations related to the original focus on material flows to and from the construction site. Ekeskär and Rudberg (2016) introduce an additional fifth role emphasizing the construction site as an integrated logistics domain, where coordination mechanisms, defined roles, and structured planning are necessary to enable effective interaction between on-site operations and the supply chain. Highlighting that improvements in upstream logistics alone are insufficient if on-site processes remain disconnected or poorly managed. Furthermore, Fredriksson et al. (2021) suggest a sixth role to expand the perspective by incorporating the relationship between construction logistics and the surrounding environment. In this view, logistics must be coordinated not only within the project and its supply chain, but also with external stakeholders such as municipalities, infrastructure systems, and nearby operations. This is particularly relevant in dense urban or sensitive environments, where construction activities must be aligned with existing societal functions.

SCM in the construction industry differs from other industries due to the large number of actors involved, each with distinct organizational structures and objectives (Lundesjö, 2015). This diversity increases the difficulty of logistics coordination. Despite these challenges, effective SCM is particularly important in construction projects, where material flow is critical for efficient use of resources and equipment. Dubois and Gadde (2002b) describe the construction supply chain as both loosely and tightly coupled. It is loosely coupled in the sense that on-site production is not directly integrated with off-site material manufacturing, making processes difficult to control and predict. For example, deliveries may originate either from warehouses, typically involving smaller orders, or directly from factories, often associated with larger quantities and longer lead times. At the same time, the supply chain is tightly coupled because on-site activities are highly dependent on planned deliveries and upstream processes. Effective coordination between these loosely and tightly connected systems is essential to ensure that required materials are available on site, thereby preventing disruptions and delays in the production schedule.

2.2.1 Supply chain integration

Supply chain integration refers to the coordination and alignment of activities, information, and material flows across different actors in the supply chain. This need for integration in construction can be understood in relation to the twofold network structure described by Dubois and Gadde (2002b). In construction projects, a clear separation exists between on-site production and upstream supply chain activities, where actors operate under different conditions and objectives. Improving supply chain integration supports the planning and control of logistics processes by recognising interdependencies between actors and integrating business processes across the supply chain (Vrijhoef & Koskela, 2000). It also facilitates communication and information sharing between actors, which improves coordination within the project (Fredriksson et al., 2025). In addition, enhanced integration increases visibility of material flows, enabling deliveries to be aligned with production schedules. Given the sequential and interdependent

nature of construction projects, reliable material flows are critical for overall project performance. Delays in deliveries can lead to cascading effects throughout the project, affecting both productivity and project timelines (Naz & Fredriksson, 2023; Peiris et al., 2023). As such, a logistics-oriented perspective has been identified as a key enabler for improving efficiency and productivity in construction projects (Wegelius-Lehtonen, 2001).

2.2.2 Silo mentality and fragmentation

While supply chain integration emphasises coordination and alignment across actors, the construction industry is often characterised by a silo mentality, where actors focus on optimising their own activities rather than the performance of the project as a whole (Morel et al., 2020). Silo mentality refers to a mindset in which different actors or organisational units operate independently, with limited information sharing between them. Vrijhoef and Koskela (2000) highlight the concept of "myopic control", where actors optimize their own activities, such as minimising purchasing costs, without considering the overall performance of the supply chain. Such local optimisation can result in inefficiencies in logistics and increased handling costs further downstream in the project. This is closely linked to the presence of functional silos within construction projects, where planning and execution are divided into parallel processes with limited integration. As a result, barriers to collaboration emerge and access to relevant information becomes restricted, further reducing coordination across the project (Morel et al., 2020). Silo mentality and fragmentation limit the ability to manage activities and material flows across the construction supply chain. This leads to misalignment between deliveries and on-site production and a higher risk of disruptions in construction projects. Consequently, achieving effective coordination requires mechanisms that can bridge these structural and organisational gaps, highlighting the importance of structured construction logistics systems.

2.3 Lean construction

Lean production was developed by Toyota during the mid 20th century as a way to compete with other large scale manufacturers (Liker, 2004). By focusing on short lead times and adaptable production lines, Toyota demonstrated that improvements in quality, customer responsiveness, productivity, and space utilization could be achieved (Liker, 2004). Rather than optimizing individual processes to minimize unit cost, the company emphasized the elimination of material and time waste across the entire value stream. This systems-oriented perspective fostered a culture centered on flow and continuous improvement.

Building on principles from lean manufacturing, lean construction emerged in the mid-1990s as an adaptation of these ideas to the construction industry (Koskela et al., 2002). Lean construction aims to design construction processes and production systems in a way that minimizes waste of materials, time, and effort. It also seeks to maximize value generation throughout the project lifecycle, from initial concept to final delivery. Workflow reliability and labor flow are regarded

as critical determinants of project performance (Vrijhoef & Koskela, 2000). An effective lean project delivery system pursues three interrelated goals: transformation, flow, and value generation (TFV-goal) (Koskela et al., 2002). Careful planning, preparation, commitment, and two-way communication are essential to achieving these goals (Paez et al., 2005). The core differences between lean construction and traditional construction are described in the table below.

Table 2.1: Core differences between traditional construction and Lean construction (Adapted from Koskela et al., 2002)

Traditional	Lean
Focus is on transactions and contracts	Focus is on the production system
T-goal, only focus on transformation, getting tasks done	TFV-goal, focus on transformation, flow and value
Fragmented and sequential decisionmaking	Downstream players are involved early in decisions
Product is designed before process	Product and process are designed in tandem
Decisions and activities are done as soon as possible, risk of lack of information	Decisions and activities are done as late as possible
Learning occurs sporadically and is not incorporated in the processes	Learning embedded in project and firm management, continuous improvement
Each actor protects their own profit, creating adversarial relationships	Contracts and incentives encourage collaboration
Large inventories are built up to protect each parties own interests	Buffers and their location are strategically sized to reduce effects of system variability

2.3.1 Push and Pull

Traditional construction planning is typically associated with a push system, where the master schedule governs production and deliveries (Kalsaas, Skaar, & Thorstensen, 2015). Critical Path Method (CPM) and other similar methods release tasks according to predefined schedules without adequately considering work-in-progress levels or the actual state of the production system (Ballard, 2000). As a result, activities are often initiated based on planned dates rather than real site readiness.

In contrast, a pull system coordinates deliveries and production activities based on actual demand from downstream processes. Materials are supplied when the site is ready to receive and use

them, making the system more responsive and reducing congestion and uncertainty (Seppänen & Peltokorpi, 2016). Visual tools such as the Kanban system are used to signal upstream processes when materials need replenishment (Kalsaas et al., 2015). However, due to long lead times, early procurement of subcontractors, and complex interdependencies, construction projects often require a combination of push and pull mechanisms. Fully implementing a pure pull system remains challenging (Ballard, 2000).

2.3.2 Last Planner System

The Last Planner System (LPS), introduced by Ballard (2000), is widely regarded as one of the most significant lean construction tools (Koskela et al., 2002). LPS addresses variability in construction by distinguishing between what should be done, what can be done, and what will be done. The "last planner" refers to the individual or group responsible for executing the work and controlling production at the operational level.

Instead of simply pushing tasks according to a master schedule, LPS incorporates shorter look-ahead schedules and collaborative short-term planning processes to improve workflow reliability. These schedules detail execution methods, assess capacity constraints, and identify a backlog of ready-to-perform tasks. By involving those who perform the work in the planning process, LPS fosters collaboration and enhances workflow reliability (Daniel et al., 2017). This participatory approach supports pull-based decision-making and reduces uncertainty.

2.3.3 Challenges of Lean Construction

Achieving a fully lean process, where each customer receives a unique product instantly and without waste, is practically impossible. Even so, striving toward leaner processes can generate substantial benefits. Implementing lean construction requires not only changes in tools and procedures but also shifts in organizational culture and mindset. While technical adjustments may be relatively straightforward, transforming habits and industry norms is significantly more difficult (Koskela et al., 2002). A common challenge is the tendency to focus on isolated improvements rather than embracing the broader lean philosophy (Granja & Picchi, 2004). Unlike manufacturing, construction projects are typically unique, with limited opportunities for standardization and long-term learning (Paez et al., 2005). Short project durations and temporary project organizations also limit knowledge transfer between projects. Despite these challenges, lean construction is theoretically well-founded and offers a compelling alternative to traditional project delivery approaches (Koskela et al., 2002). It emphasizes teamwork, problem-solving, and creative thinking, recognizing that technical tools alone are insufficient. Ultimately, the effectiveness of lean construction depends on the competence, collaboration, and commitment of all participants involved in the project.

2.4 Construction Supply Chain Risk Management

Supply chain risk management (SCRM) emerged as a distinct research field in the early 2000s (Norrman, 2025). Prior to this, most discussions focused on firm-specific logistical and operational risks, such as inventory control, transportation reliability, and supplier performance management. These issues were typically addressed within the broader framework of SCM, but without an explicit and systematic risk perspective. As supply chains became increasingly globalized, interconnected, and complex, the vulnerability of entire supply networks to disruptions became more apparent, highlighting the need for a more structured approach to managing risk across organizational boundaries. Several definitions of SCRM have been proposed in the literature. One definition describes SCRM as "....to collaborate with partners in a supply chain apply risk management process tools to deal with risks and uncertainties caused by, or impacting on, logistics related activities or resources" (Norrman & Jansson, 2004). This definition emphasizes two central elements: inter-organizational collaboration and the systematic application of risk management processes. Unlike traditional risk management, SCRM acknowledges that risks frequently originate outside the focal firm and propagate through the supply chain network.

In general terms, SCRM can be understood as a structured process consisting of risk identification, risk assessment, risk mitigation, and continuous monitoring. Jüttner et al. (2002) suggest organizing risk sources relevant for supply chains into three categories: External risk, internal risk and network risk. The objective of SCRM is not necessarily to eliminate risk entirely, which is often impossible, but to enhance resilience and reduce vulnerability.

Figure 2.3: Jüttner et al. (2002) definition of risk

SCRM in construction differs in several important ways from manufacturing and other industrial supply chains. Construction supply chains are typically project-based and involve multiple independent actors such as clients, general contractors, subcontractors, suppliers, and

consultants. This structural complexity increases exposure to uncertainty and makes coordinated risk management more challenging. According to Baghalzadeh Shishehgarkhaneh et al. (2024) construction supply chains are particularly vulnerable due to low integration, limited transparency, and short-term contractual relationships that reduce incentives for long-term risk-sharing arrangements.

2.4.1 Risk characteristics in construction supply chains

Construction supply chains are characterised by a high degree of complexity, uncertainty, and time pressure, often described as complex, uncertain, and quick (CUQ) (Wegelius-Lehtonen, 2001). These conditions stem from the project-based and temporary nature of construction, where multiple independent actors are assembled for a limited period and operate within dynamic and often constrained environments (Fernández-Solís, 2008; Sobotka & Czarnigowska, 2005). A defining characteristic of construction projects is the strong interdependence between activities, which are typically carried out in sequence. As a result, delays in one activity can propagate throughout the project, creating cascading effects that impact both timelines and costs (Koskela et al., 2002; Naz & Fredriksson, 2023). This sequential dependency makes construction supply chains particularly sensitive to disruptions in material flows and coordination failures.

In addition, construction projects are often carried out in constrained and complex environments, particularly in urban settings. Limited space for storage and transportation increases reliance on timely deliveries and efficient logistics planning. Poor material handling, lack of storage capacity, and traffic-related disruptions can therefore introduce significant risks to project performance (Wegelius-Lehtonen, 2001; Brusselaers et al., 2024). The fragmented structure of construction supply chains further increases exposure to risk. Short-term contractual relationships, low levels of integration, and limited transparency reduce the ability of actors to collaborate effectively and manage uncertainties collectively (Fredriksson et al., 2024; Baghalzadeh Shishehgarkhaneh et al., 2024).

2.4.2 Network risks and logistics coordination

Given these characteristics, network risks play a particularly important role in construction supply chains. These risks arise from the interactions between actors and are closely related to coordination, communication, and information sharing across organisational boundaries (Jüttner et al., 2002). From a logistics perspective, network risks are closely linked to the management of material flows. Poor information sharing between contractors, subcontractors, and suppliers can lead to misalignment between delivery schedules and on-site production, resulting in delays, congestion, and inefficient material handling. Limited visibility of material flows and delays in information sharing further increase uncertainty and reduce the ability to respond to disruptions effectively (Naz & Fredriksson, 2023; Fredriksson et al., 2025). The interdependent and sequential nature of construction activities means that disruptions in deliveries can quickly propagate throughout the project, creating cascading effects on productivity and project timelines

(Peiris et al., 2023). As a result, risks in construction supply chains are not isolated but systemic, affecting multiple actors and processes simultaneously. To mitigate these risks, construction projects increasingly rely on coordination mechanisms that improve integration and information sharing across actors. Structured approaches to construction logistics, including improved planning, controlled delivery processes, and clearer interfaces between supply chain actors, can reduce uncertainty and enhance predictability. Consequently, effective risk management in construction supply chains is closely linked to the ability to coordinate material flows and activities across organisational boundaries.

2.5 Construction logistic setup

Ensuring that materials are delivered in the correct quantities and at the appropriate time is essential for the smooth execution of construction projects, and this responsibility falls within logistics management (Lundesjö, 2015). Effective logistics management contributes to maintaining available space on-site, reducing congestion, and improving overall site efficiency. Moreover, it facilitates the optimal utilisation of the construction sites resources. To address the increasing logistical complexity of modern construction projects, several management practices have been developed. The ones discussed in this chapter include the Construction Logistics Plan, Construction Site Layout Plan, Logistics Manager, Delivery Management Systems, Construction Consolidation Centres and Transport Checkpoints.

2.5.1 CLP - Construction logistics plan

A Construction Logistics Plan is a formal document designed to plan, coordinate, and streamline logistical processes throughout a construction project (Lundesjö, 2015). Its purpose is to provide a comprehensive and structured overview of logistics activities from project initiation through construction and final commissioning, covering all intermediate phases. The CLP promotes a more systematic and controlled approach to construction logistics, an area where the industry has traditionally lacked structure and long-term coordination (Ying et al., 2018). It is typically developed by the general contractor or consultants. The CLP outlines project-specific logistical constraints such as site access conditions, storage limitations, delivery routes, resource availability, and waste handling requirements.

Beyond serving as a planning document, the CLP functions as a communication tool for project management (Janné & Fredriksson, 2021). It supports material receiving, on-site storage, internal distribution, and waste management across the supply chain. By clarifying responsibilities and processes, the CLP can enhance transparency and facilitate alignment between contractors, subcontractors, and suppliers (Thunberg & Fredriksson, 2023). Despite its potential benefits, the practical application of CLPs remains limited. In many projects, logistics coordination is restricted to on-site operations, with insufficient consideration of upstream and downstream supply chain activities (Vrijhoef & Koskela, 2000). This narrow focus reduces the effectiveness

of logistics planning and undermines the possibility of achieving fully integrated supply chain management (Ekeskär & Rudberg, 2016).

2.5.2 Construction Site Layout Plan

Creating a construction site layout is a fundamental step in establishing a shared understanding of how site space should be organized and utilized. A clear visual representation of the site supports coordination and can contribute to reduced project duration (Hammad et al., 2007; Ma et al., 2005; Russell et al., 2009). Despite being considered a standard task for site and project managers, site layout planning has historically received limited analytical attention (Hayes-Roth et al., 1992a). The complexity stems from the need to allocate limited space to multiple temporary and permanent objects while simultaneously accommodating changes driven by the construction schedule. As production progresses, spatial requirements shift, requiring continuous adaptation. Moreover, site layout decisions often involve conflicting objectives. For example, positioning facilities to minimize workers travel time may increase site congestion or interfere with material flows. Consequently, management must prioritize among competing considerations based on project-specific constraints.

Because this complexity is rarely fully addressed, many construction sites operate without optimized layouts, thereby missing opportunities for efficiency improvements. Dawood and Mallasi (2004) estimate that workspace interferences alone may reduce productivity by up to 40 percent. At the same time, it is often difficult to directly quantify cost savings resulting from improved site disposition, making it challenging to justify investments in detailed planning. Site layout components such as temporary facilities, storage areas, equipment zones, and access roads can account for up to 10 percent of a project's direct costs (Andayesh & Sadeghpour, 2015; Hayes-Roth et al., 1992b). Handa and Lang (1989) further suggest that the potential savings from effective pre-planning may be four to eight times greater than the cost of the planning effort itself. Hayes-Roth et al. (1992b) conclude that a well-designed layout yields significant benefits when sufficient time and managerial commitment are devoted to its development and maintenance. Despite its importance, site layout planning is often treated as an isolated task, addressed only after construction scheduling, resource allocation, and budgeting have been completed (Hayes-Roth et al., 1992b). In addition, layout design may be influenced by the individual responsible, depending on their prior experience, project involvement, priorities, and professional relationships. Russell et al. (2009) identify two primary principles guiding site layout decisions: either prioritizing proximity between labor-oriented facilities and work areas to reduce worker travel time, or positioning material-oriented facilities closer to work zones to minimize material handling distances. Expanding on this, Andayesh and Sadeghpour (2015) describe three main approaches to site layout planning:

1. Static site layout planning, where the site is represented as unchanged over time and all objects are assumed to remain in place throughout the project.

2. Phased site layout planning, where the project is divided into time intervals, with a separate layout developed for each phase.
3. Dynamic site layout planning, where space is allocated based on the lifecycle of each object, allowing reassignment of areas as project needs evolve. This approach provides a more realistic representation of changing space requirements.

A realistic and continuously updated site layout is essential (Hayes-Roth et al., 1992b). As site conditions and occupancy change during construction, layout plans should be reviewed and adjusted accordingly (Andayesh & Sadeghpour, 2015). However, in practice, layout drawings are rarely updated as projects progress, reducing their relevance and limiting their effectiveness as management tools (Hayes-Roth et al., 1992b).

2.5.3 Logistics Manager

The role of the logistics manager is relatively new within the construction industry, although the need for coordinated logistical processes has long been recognized (Lundesjö, 2015). As construction projects become more complex, particularly in densely populated urban environments, the importance of efficient logistics continues to grow (Brown, 2013). Clients are often aware of the significant impact that poor logistics planning can have on project costs and quality (Lundesjö, 2015).Logistics management in construction must also adapt to technological developments, including Building Information Modelling (BIM) and advanced IT solutions. The primary responsibility of a logistics manager is to oversee all logistics-related aspects of the project's supply chain, including the management of material, personnel, and equipment flows throughout the construction process (Fredriksson et al., 2024). This involves planning and managing site logistics to ensure safe and efficient operations, such as organizing storage areas, and determining how materials, machinery, and workers should move throughout the construction site. In addition, the logistics manager is responsible for coordinating daily, weekly, and short-term material flows, as well as managing subcontractors from a logistics perspective to ensure smooth project execution. Brown (2013) emphasizes that the construction logistics manager acts as a link between production, suppliers, and transportation actors in order to improve coordination and reduce inefficiencies on-site. Effective logistics management is therefore essential for minimizing delays, congestion, unnecessary material handling, and increased project costs. Furthermore, logistics management should be integrated early in the project planning phase rather than being treated solely as an operational support function during construction (Brown, 2013).

2.5.4 CCC - Construction Consolidation Centre

The construction industry generates a substantial volume of transportation activity, primarily due to the continuous flow of materials to and from construction sites (Lundesjö, 2015). Materials are often sourced from multiple suppliers, each arranging deliveries independently and with limited coordination regarding timing or sequencing. This fragmented delivery structure frequently leads

to congestion at construction sites. Moreover, many deliveries consist of small quantities resulting in an unnecessarily high number of transport movements. To address these challenges and improve delivery precision, Construction Consolidation Centres have been proposed as an effective logistical solution (Hamzeh et al., 2007; Lundesjö, 2015). A CCC functions as an intermediate buffer storage facility where materials are temporarily stored before being transported to the construction site (Sullivan et al., 2010). By centralizing inbound deliveries, the CCC enables greater control over scheduling and coordination, reducing the risks associated with having subcontractors or suppliers deliver directly to the site (Lange & Schilling, 2015).

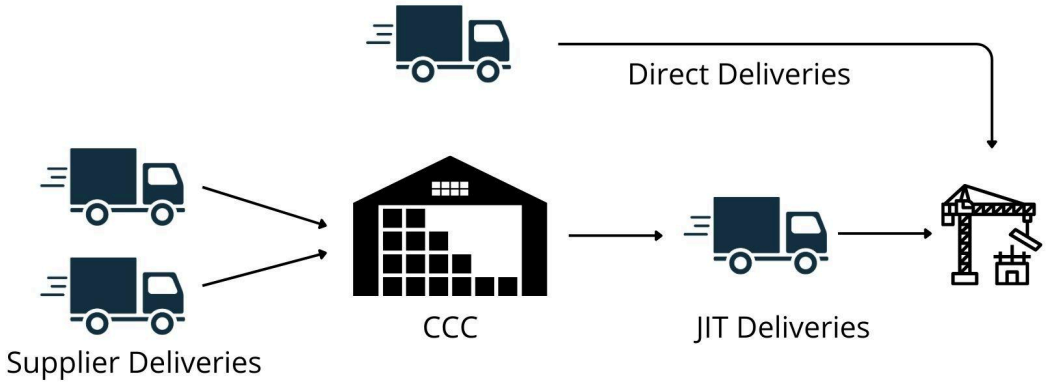

Figure 2.4: Description of the way a CCC works in construction

CCCs are multifunctional and can generate several logistical benefits (Hamzeh et al., 2007). From a storage perspective, they allow contractors to reduce on-site inventory levels while still maintaining material availability. Because materials are stored off-site, contractors can place larger bulk orders, often at lower unit prices, without being constrained by limited site storage capacity. These bulk deliveries can then be broken down, sorted, and repacked at the consolidation centre before being distributed to the site in smaller, project-specific batches. When a CCC serves multiple projects simultaneously, additional efficiencies may arise. Shared safety stock across projects reduces total inventory levels, while coordinated distribution enables so-called “milk runs,” where a single transport serves several projects in one route instead of separate deliveries for each order (Lundesjö, 2015). This approach can significantly reduce overall transport movements.

The outbound flow from a CCC typically operates as a pull system, meaning that materials are dispatched to the construction site only when requested. Deliveries that would otherwise originate from numerous suppliers are consolidated into fewer, more structured shipments. In a study of Heathrow Airport in England it was shown that CCCs are particularly effective in dense urban environments where construction sites often face severe space constraints (Sullivan et al., 2010). Their findings indicate that construction vehicle movements were reduced by up to 50 percent through the use of a consolidation centre. The Heathrow case study where one CCC served four concurrent construction projects demonstrated that cost savings could be achieved

through faster turnaround times and improved on-site productivity. In addition, delivery precision was significantly improved. Despite these documented advantages, CCCs are less widely implemented than expected (Lundesjö, 2015). A key barrier is the highly competitive nature of construction procurement processes, which discourages stakeholders from committing to additional upfront costs without guaranteed returns. For example, in the London case referenced by Lundesjö (2015), a 3,000-square-metre consolidation centre cost approximately 10 million SEK annually to operate while supporting a project valued at 4 billion SEK. Although potential savings and efficiency improvements were identified, they were difficult to quantify precisely, making stakeholders hesitant to adopt the model.

2.5.5 Delivery Management Systems

A delivery management system (DMS) provides a structured framework for coordinating inbound and outbound logistics at construction sites. According to Lundesjö (2015), such systems support the planning and control of deliveries by scheduling vehicle arrivals, allocating unloading zones, and notifying site management when shipments are approaching or have arrived. By managing access to the site and controlling the resources required for loading and unloading, a DMS enables contractors to accept, postpone, or reject deliveries that arrive too early or too late. This reduces disruptions and improves site flow efficiency.

Delivery management systems can vary a lot in complexity and technological sophistication. Lundesjö (2015) describes a couple of usually used systems:

1. Manual systems (e.g. whiteboards)
   A common solution in practice remains the use of whiteboards in site offices to track delivery schedules. This can work in smaller projects where one person manages logistics. However, manual systems rely heavily on human input and are therefore prone to errors, miscommunication, and missed updates. They also reflect what Ying et al. (2018) describe as an “ad hoc” approach to construction logistics, where issues are handled on a day-to-day basis rather than through structured and systematic planning. While simple and low-cost, such systems offer limited support for coordination in more complex projects.
2. Spreadsheet-based systems
   A more structured alternative involves the use of spreadsheets to document delivery bookings. While offering improved organization compared to whiteboards, spreadsheets still rely heavily on manual updates and operator accuracy.
3. Digital delivery management systems
   Fully digitalized DMS platforms are typically implemented on larger and more complex construction sites. These systems function as multi-user platforms that can be accessed and managed from multiple locations. Digital systems reduce the risk of double-booking unloading zones, ensure that necessary equipment and personnel are prepared for incoming deliveries, and improve real-time visibility of material flows.

By synchronizing delivery schedules with site capacity, digital systems can minimize truck waiting times, reduce congestion, and ensure that sufficient storage space is available upon arrival (Seppänen & Peltokorpi, 2016). Despite advantages, digital delivery management systems involve higher implementation and operational costs (Thunberg & Fredriksson, 2023). Research also shows that advanced digital logistics solutions are more commonly implemented in large and complex construction projects, while smaller projects often rely on simpler and more ad hoc coordination methods (Fredriksson et al., 2024). Consequently, the selection of a delivery management system should be aligned with project size, logistical complexity, and the required level of logistical control and planning.

2.5.5 Transport checkpoints

A transport checkpoint refers to a designated control point within a construction logistics system where deliveries and transport activities to a construction site are regulated. Dubois et al. (2019) highlight how organising transport activities is essential to reduce inefficiencies and disruptions in construction projects. Although transport checkpoints are not always treated as a stand-alone concept, they function as a concrete operational mechanism within broader construction logistics solutions. Transport checkpoints may be operated by a third-party logistics provider, often as part of a Construction Logistics Centre arrangement, or be directly managed by the contractor at the construction site. In highly constrained urban projects, checkpoints may also function as mandatory control points used to regulate and sequence deliveries before vehicles are allowed to enter the construction site (Ekeskär & Rudberg, 2016). Checkpoints can be categorized as a specific type of Just-In-Time solution within the broader CLS framework (Thunberg & Fredriksson, 2023).

The primary purpose of transport checkpoints is to improve coordination, reduce congestion, enhance safety, and ensure that unloading resources are prepared when deliveries arrive. Ekeskär and Rudberg (2016) explicitly show that checkpoints can be implemented to avert traffic disturbances and protect sensitive third-party operations in urban environments. Furthermore, Sezer and Fredriksson (2021) emphasise that managing arrival points enables alignment between vehicle arrivals, unloading equipment availability, and crew schedules, thereby reducing on-site congestion and idle time. By regulating the inflow of vehicles, checkpoints support synchronization between transport and on-site production activities.

Figure 2.5: Description of the checkpoint as a logistics control point

Recent research highlights the growing role of digital technologies in checkpoint management. Janné and Fredriksson (2021) describe the use of electronic gates and distributed gate codes to regulate delivery access. Similarly, Sezer and Fredriksson (2021) suggest the use of sensors or RFID tags at entry gates to automatically capture arrival and departure times, reducing the need for manual control. More advanced digitalisation strategies include IoT-enabled monitoring systems. Smart technologies enabling real-time monitoring of transport flows can significantly improve coordination and overall construction efficiency (Peiris et al., 2023). Through automated registration, licence plate recognition, and real-time tracking, the workers can focus more time on value adding activities.

2.6 Procurements part in construction logistics

The chosen form of procurement influences the structure, integration, and performance of construction logistics. Procurement arrangements shape communication pathways, information flows, allocation of responsibilities, and the nature of relationships between supply chain actors. Briscoe et al. (2004) highlights that procurement strategies can affect logistics either by simplifying communication between parties, encouraging enhanced information sharing, or fostering long-term collaboration. Walker and Lloyd-Walker (2015) identify three fundamental procurement approaches:

1. The traditional approach
2. The planning and control approach
3. The collaboration and coordination approach

Each approach has distinct implications for logistical planning, material flow, communication structures, and risk distribution within the construction supply chain.

2.6.1 Traditional Approach

The traditional approach is characterized by a clear division between the design phase and the construction phase (Walker & Lloyd-Walker, 2015). One of the most widely used procurement forms globally within this category is Design–Bid–Build (DBB) (Forbes et al., 2011; Walker & Lloyd-Walker, 2015). Under DBB, the design is expected to be fully completed before tendering begins. Contractors then compete primarily on price (and sometimes time), based on detailed design documentation. Responsibilities are divided: the client and its consultants manage the design phase, often led by an architect or engineer (Mohsini & Davidson, 1992), while the general contractor manages construction, subcontractors, and suppliers during the execution phase.

From a logistics perspective, this separation can create coordination challenges. Since contractors and suppliers are typically not involved during the design phase, opportunities for

early logistics optimization such as prefabrication planning, lead-time adjustments, or material standardization may be limited (Masterman, 2001). The limited integration between design and construction increases the risk of contract variations. Although the overall project objectives may remain stable, detailed changes can result in delays, rework, and disrupted material flows (Walker & Lloyd-Walker, 2015). A commonly cited criticism of DBB is the "bid low, claim high" mentality, where contractors submit competitive bids and later rely on claims resulting from design ambiguities or variations (Lu et al., 2017). From a supply chain perspective, this can generate adversarial relationships, reduced trust, and reactive rather than proactive logistics management. However, DBB also offers advantages. The high level of design detail reduces uncertainty for contractors during execution, enabling firms with strong operational capabilities to plan logistics efficiently and potentially reduce overall costs (Walker & Lloyd-Walker, 2015). Nonetheless, insufficient or incomplete design documentation remains one of the major causes of delays and logistical inefficiencies (Forbes et al., 2011).

2.6.2 Planning and Control Approach

Procurement forms within the planning and control approach emphasize structured systems, formal coordination mechanisms, and integrated responsibility rather than relational collaboration (Walker & Lloyd-Walker, 2015). A central example is Design–Build (DB), also referred to as Design and Construct (D&C) (Beard et al., 2001). Unlike DBB, DB integrates design and construction responsibilities within a single entity (Sacks, 2013; Walker & Lloyd-Walker, 2015).This integration has important logistical implications. Because design and construction are managed holistically, supply chain considerations can be incorporated earlier in the project lifecycle. Early contractor involvement enables better coordination of procurement schedules, supplier selection, prefabrication strategies, and site logistics. Furthermore, DB often results in shorter project durations due to overlapping design and construction activities (Forbes et al., 2011; Sacks, 2013).

From a logistics standpoint, DB reduces communication complexity and improves information flow across the supply chain. It also allows project owners to transfer greater responsibility and risk for cost, quality, and time performance to the contractor (Beard et al., 2001). However, this concentration of responsibility may also increase dependency on the general contractors supply chain management capability. Another procurement form associated with this approach is Integrated Supply Chain Management (ISCM) (Walker & Lloyd-Walker, 2015). ISCM focuses explicitly on optimizing the supply chain to maximize value creation. It often involves reducing the number of subcontractors and suppliers to a core group of strategic partners. The rationale is that a smaller, committed network fosters trust, stronger relationships, and improved coordination. ISCM emphasizes practices such as just-in-time deliveries. JIT can enhance efficiency and reduce inventory costs on-site, but it also increases sensitivity to disruptions if planning reliability and supply chain synchronization are insufficient. Thus, while ISCM may

strengthen logistical performance through integration and lean practices, it also requires high levels of supply chain maturity and transparency.

2.6.3 Collaboration and Coordination Approach

The collaboration and coordination approach emphasizes relational governance, trust, and joint problem solving. Rather than being a standalone procurement method, partnering is often described as a philosophy that can be applied to other procurement forms (Walker & Lloyd-Walker, 2015). Partnering has been widely debated in the construction industry. Some view it as a solution to fragmentation and adversarial relationships, while others regard it as a rebranding of common-sense collaboration (Nyström, 2005). In dynamic and uncertain environments, flexibility and responsiveness are critical competitive capabilities (Thompson & Sanders, 1998). Partnering arrangements can support these capabilities by fostering trust-based relationships and open communication. Trust is consistently identified as a cornerstone of successful partnering arrangements (Crane et al., 1997; Kadefors et al., 2004; Thompson & Sanders, 1998). From a logistics perspective, trust reduces transaction costs, improves information sharing, and facilitates joint planning of procurement and material flows.

Two main forms of partnering are typically distinguished:

- Strategic partnering, which involves long-term collaboration between supply chain actors across multiple projects and focuses on continuous improvement (Cheng et al., 2004; Walker & Lloyd-Walker, 2015).
- Project partnering, which is limited to a single project and involves multiple stakeholders within that project (Walker & Lloyd-Walker, 2015).

Strategic partnering is generally process-oriented and supports learning and logistical optimization across projects. Project partnering, however, raises questions regarding whether trust and collaborative culture can truly be established within a single project's limited timeframe (Kadefors et al., 2004).

2.7 Conceptual Research Framework

Based on the literature reviewed in this chapter, a conceptual research framework was developed to guide the empirical analysis of construction logistics within the case project. The framework integrates insights from construction supply chain management, lean construction, and supply chain risk management in order to analyse how logistics systems are planned, coordinated, and implemented in construction projects. The framework combines two theoretical perspectives. The first concerns construction supply chain design, focusing on the project-based structure of construction supply chains, actor fragmentation, and the configuration of material flows. The second perspective addresses risk and coordination. Highlighting how external, internal, and network-related risks, together with fragmented decision-making and interdependencies between actors, influence logistics performance in construction projects.

Based on these perspectives, the framework structures the analysis into three stages: Construction logistics context, logistics planning and identification of constraints and disruptions, and evaluation of logistics solutions. The framework also considers the expected performance implications of logistics planning and solutions in terms of improved coordination, reduced disruptions, and more efficient material flows. Lastly, the framework incorporates an actor perspective, examining the logistics process from the viewpoints of the general contractor, third-party logistics providers, and digital logistics system provider.

The conceptual research framework serves as the analytical foundation for the empirical study and guides the data collection and analysis conducted in this thesis.

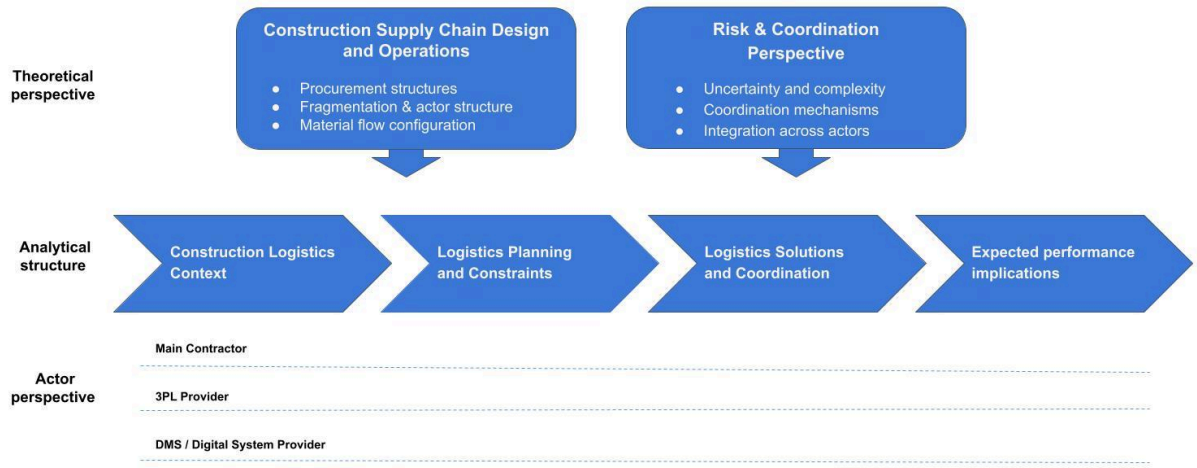

Figure 2.6: Conceptual research framework

3. Methodology

This chapter presents the methodological approach adopted in the thesis. It describes the overall research design and motivates the chosen methods, outlines how empirical data has been collected and analysed, and explains how the quality of the study has been ensured through considerations of reliability and trustworthiness.

3.1 Research Design

The purpose of this study is to investigate how construction logistics can be planned and implemented to enhance efficiency and reduce disruptions in construction projects. To address this objective, a qualitative research design based on a single case study was adopted, focusing on the “Tillbyggnad Lund” (TBL) project. Research can be defined as a systematic investigation aimed at increasing knowledge and understanding through structured inquiry and analysis. According to Fellows and Liu (2008), research involves both identifying relevant phenomena and applying methods to investigate relationships, processes, and outcomes within a specific context. Construction management research often deals with systems involving multiple actors, organizational processes, and contextual factors. Therefore, qualitative approaches are frequently used to explore interactions, behaviors, and decision-making processes within construction projects. Such approaches emphasize the collection and interpretation of non-numerical data, such as interviews, observations, and documents, enabling researchers to gain a deeper understanding of participants' experiences, perceptions, and the factors influencing project outcomes (Fellows & Liu, 2008).

Case study research is particularly suitable when studying contemporary phenomena within their real-life context, especially when the boundaries between the phenomenon and the context are not clearly defined (Yin, 2018). By focusing on a specific construction project, it becomes possible to examine logistics processes and operational challenges in more detail. According to Yin (2018), case studies can be designed for different purposes, including exploratory and explanatory research. The research design of this study can be characterized as an exploratory and explanatory single case study, aiming both to explore construction logistics practices and to understand how different logistics solutions influence efficiency and risk management in practice. The overall research process applied in this thesis is illustrated in Figure 3.1. The research process began with an initial specification of the research aim and a review of relevant literature within construction logistics, supply chain management, and risk management. Based on the literature review, a conceptual framework was developed to guide the empirical investigation. The empirical phase consisted primarily of interviews with actors involved in construction logistics, complemented by project-related documentation. The collected data was then analysed in relation to the conceptual framework in order to identify patterns related to logistics planning, constraints, and logistics solutions. The research process was iterative,

allowing insights from the empirical findings to further inform the theoretical understanding throughout the study. Therefore the study follows an abductive approach, which is characterized by a continuous interplay between theory and empirical data (Dubois & Gadde, 2002a).

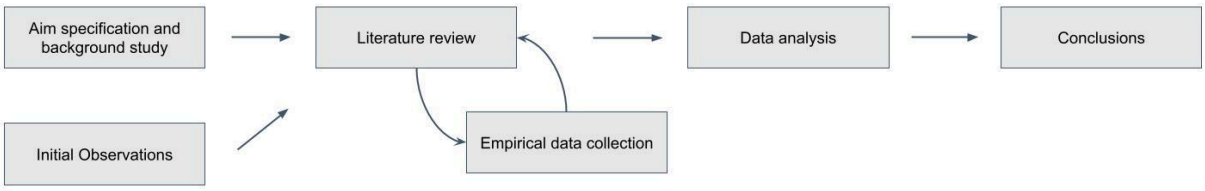

Figure 3.1: Research process applied in the thesis

3.2 Research Philosophy & Approach

Research philosophy refers to the underlying assumptions regarding how knowledge is generated, interpreted, and understood within a research study. These philosophical assumptions influence how researchers conceptualize reality, how knowledge is acquired, and which methods are considered appropriate for investigating a particular phenomenon (Saunders et al., 2023). In construction management research, research philosophy plays an important role in shaping the overall research design and guiding the interpretation of empirical findings. Within construction research, two major philosophical perspectives are commonly discussed: positivism and interpretivism (Fellows & Liu, 2008). Positivism assumes that reality exists independently of the researcher and that objective facts can be observed and measured through systematic empirical investigation. The researcher is expected to remain detached from the phenomenon being studied, and knowledge is typically generated through quantitative methods, hypothesis testing, and the search for causal relationships. In contrast, interpretivist research emphasizes that reality is socially constructed and that understanding human behavior and organizational processes requires interpretation of participants' perspectives (Saunders et al., 2023).

Since this study focuses on understanding logistics practices, coordination between actors, and perceived constraints within a construction project, the research adopts an interpretivist perspective. Construction logistics systems involve interactions between multiple stakeholders, including contractors, logistics managers, and supply chain partners. Understanding these interactions requires insight into how actors perceive logistics processes, challenges, and improvement initiatives within the project context. Interpretivist approaches are therefore particularly relevant in construction management research, where organizational practices, decision-making processes, and collaboration between actors play a significant role in shaping project outcomes (Fellows & Liu, 2008). By adopting an interpretivist perspective, this study aims to capture the experiences and perspectives of actors involved in construction logistics and

to develop a deeper understanding of how logistics practices are implemented and managed within the case project.

3.3 Case Study Research

Case study research is one of several research strategies commonly used in empirical research, alongside methods such as experiments, surveys, and archival analysis (Yin, 2018). The choice of research strategy depends on several factors, including the type of research question, the degree of control over behavioural events, and whether the study focuses on contemporary or historical phenomena. In this study, the research questions are formulated using “how”, focusing on how construction logistics can be planned, implemented, and managed in practice. Such questions are particularly suited to case study research, as they aim to understand processes and interactions within a real-world context rather than test causal relationships in controlled environments. Furthermore, the study investigates logistics practices within an ongoing construction project without manipulating the studied processes. According to Yin (2018), case studies are particularly appropriate when examining contemporary phenomena within their natural settings where the researcher has limited control over events. Case study research enables an in-depth investigation of a specific phenomenon using multiple sources of evidence, such as interviews, observations, and project documentation (Leonard-Barton, 1990). This approach is well suited for construction management research, where projects involve complex interactions between multiple actors and organisational processes.

The unit of analysis in this study is the construction logistics system within the TBL project, including the planning, coordination, and implementation of logistics activities among the involved actors. A single case study design was selected for this research. According to Yin (2018), single case studies are appropriate when investigating a representative or typical case that allows for an in-depth understanding of a phenomenon. The TBL project represents a suitable case due to its complex logistics environment, involving multiple actors, limited site space, and construction activities conducted within an operational hospital setting. Studying this case enables a detailed examination of how construction logistics practices are organised and implemented in practice.

3.3.1 Case introduction

The TBL project is a construction project commissioned by Region Skåne and involves an expansion of Lund University Hospital. The project consists of the construction of two new buildings that will be physically connected to existing hospital structures, as illustrated in Figure 3.2. The building sites are situated in close proximity to each other, approximately 100 meters apart, and share the same surrounding infrastructure, including access roads, although they are accessed through separate entry points. Construction activities are carried out within an operational hospital environment, where building operations take place alongside ongoing

healthcare services. This creates a complex project setting where construction logistics must be carefully planned and coordinated in order to minimise disruptions to both hospital operations and construction activities. The project involves several actors with defined responsibilities in relation to construction logistics. For the purpose of this study, the focus is placed on three key actors involved in the logistics system:

1. PEAB, the general contractor responsible for the overall execution of the construction project

2. AkkaFrakt, the third-party logistics provider responsible for logistics and transport-related operations

3. Myloc, the provider of the digital delivery management system used for planning and coordinating deliveries

Due to the sensitive project location, the client has placed specific requirements on the contractor to minimise disturbances to the ongoing healthcare activities. In addition, the construction site is located in an area with very limited available space, which restricts both the reception of deliveries and the on-site storage of construction materials. As a result, the project requires carefully coordinated logistics planning in order to manage deliveries and material flows efficiently. To support collaboration and transparency between the client and the general contractor, the project is carried out under a design-build partnering contract with an open-book structure, allowing both parties to jointly manage project costs and logistics planning. The logistics setup in the TBL project therefore combines several actors, systems, and integrated logistics functions. AkkaFrakt, the contracted third-party logistics provider, is responsible for off-site logistics operations including temporary storage at two logistics locations, management of a logistics checkpoint where direct deliveries wait before continuing to the construction site and handling of waste materials. In addition to the 3PL operations, a logistics manager from an external logistics management company is responsible for overseeing the implementation of the construction logistics plan and coordinating logistics activities between the different actors involved in the project. A Construction Logistics Plan has been developed for the project in order to define logistics procedures, delivery rules, and responsibilities among the actors involved. The CLP outlines how deliveries should be scheduled, how materials should be handled on site, and how logistics activities should be managed throughout the construction process. To support these logistics activities, Myloc Construction is used as the digital logistics management platform where deliveries are scheduled and coordinated. Together, these logistics arrangements form the logistics system used in the TBL project, combining physical logistics operations, digital tools, and dedicated logistics management roles in order to manage construction logistics.

Figure 3.2: Renderings of the planned additions to Lund University Hospital (Peab, 2026; illustrations by Sweco Architects/Region Skåne).

3.4 Data Collection

The data collected in this study was primarily qualitative. Data collection was conducted through multiple sources, including interviews, observations and documentation, allowing for a deeper understanding of the studied phenomenon. This approach works well with case study research, where the use of multiple data sources enables a richer and more comprehensive understanding of the empirical context (Dubois & Gadde, 2002a).

3.4.1 Interviews

Interviews were the main source of data in this thesis, which is common in case research (Yin, 2018). They enabled deep insights into logistics planning, constraints, and decision-making within the studied case, capturing context-specific knowledge that would be difficult to obtain through other data sources. A semi structured interview approach was adopted, as this format provides a balance between consistency across interviews and flexibility to explore issues that emerge during the conversation (Fellows & Liu, 2008). Pre-planned questions ensured relevance while also allowing for follow-ups and deeper insights. Prior to the interviews, a question template was constructed based on the initial observations and findings made in the literature research. The template was adapted depending on the respondents role, allowing for both project-specific insights and more general perspectives on construction logistics. The interviews were conducted in Swedish, while the interview guides presented in the appendix A and B are translated into English.

The interviews were conducted face to face or digitally depending on availability and lasted between 30–60 minutes. All interviews were recorded and transcribed to ensure accuracy. In line

with the abductive approach, insights from earlier interviews informed subsequent data collection. This allowed subsequent interviews to focus and explore deeper into emerging patterns.

The interviewees were selected based on their direct involvement in the projects planning, operations and logistics processes. The selection included key roles within the logistics system, such as representatives from the client, contractor, logistics manager, third-party logistics, and the digital system provider. In addition, one external expert interview was conducted to provide a broader perspective on current construction logistics practices and industry challenges. Thereby complementing the project-specific insights obtained from the case study participants.

Table 3.1: List of Interviewees

Interviewees	Organization	Role	Date	Format
Respondent A	Myloc	Product manager	10/3	In-person
Respondent B	BLS	Logistics manager	17/3	In-person
Respondent C	Myloc	Senior Consultant	18/3	In-person
Respondent D	PEAB	Logistics development manager	19/3	Teams
Respondent E	Consultant firm	Senior manager	20/3	Teams
Respondent F	AkkaFrakt	Business developer	26/3	Teams
Respondent G	Linköping University	Professor	26/3	Phone
Respondent H	PEAB	Project manager	7/4	In-person
Respondent I	Consultant (AkkaFrakt)	Sales	9/4	Teams
Respondent J1, J2	Region Skåne	Project manager & Area manager	13/4	In-person
Respondent K	PEAB	Site manager	13/4	In-person
Respondent L	AkkaFrakt	Operations manager	20/4	Teams

3.4.2 Documentation

Documents constituted an important complementary data source in this study. According to Yin (2018), documentation is a valuable source of evidence in case study research, as it provides contextual information and can be used to corroborate findings from other data sources. Internal project documents, such as the construction logistics plan and the construction site layout plan,

were collected and reviewed to gain an understanding of the project's logistics setup, constraints, and planning conditions. In addition, operational planning data retrieved from the digital logistics system was collected to capture information regarding delivery schedules and ongoing logistics activities. These documents provided factual information about the project's logistics arrangements and enabled the researcher to compare planned logistics procedures with the perceptions and experiences described by interview participants.

3.4.3 Observations

Observations were conducted as a complementary data collection method to gain direct insights into the logistics operations within the case project. Observations are a valuable source of evidence in case study research as they enable researchers to study phenomena directly within their real-life context and to capture activities and behaviours as they occur (Yin, 2018). By observing ongoing activities, it was possible to capture how logistics activities and operational processes were carried out in practice, beyond what was expressed in interviews. The observations also enabled a comparison between observed practices and information obtained from interviews and project documentation. Observations were made both on-site and at relevant 3pl locations. The observations provided contextual understanding of the logistics system and served to corroborate findings from interviews and documents.

Several on-site observations were conducted, both pre-planned and more informal, unplanned observations. The researcher took a non-participant role. This corresponds to what Yin (2018) describes as direct observation, where activities are observed without direct involvement in the studied processes. Pre-planned observations consisted of structured site walkthroughs, providing a systematic overview of logistics processes and site conditions. The more informal observations focused on day-to-day logistics activities, capturing how operations were carried out in practice. In addition, a structured walk-through was conducted together with the third-party logistics actors at their facilities, providing further insights into operational processes and material flows.

Table 3.2: List of pre-planned observations

Location	Type of observation	Date
Construction site	Initial on-site observation	24/2
Construction site	Detailed site walkthrough	11/3
Logistics terminal	Cross-docking process observation	25/3
Checkpoint	Entry control and delivery flow observation	25/3
Storage facility	Long-term storage and waste consolidation observation	25/3
Construction site	Follow-up site walkthrough	23/4

3.5 Data Analysis

The collected data was analyzed using a qualitative and iterative approach. In line with the abductive research design, the analysis involved a continuous interplay between empirical findings and theoretical concepts, allowing for refinement of both throughout the process. The analysis was guided by the research purpose and relevant theoretical concepts. These structured the analytical process by directing attention to key aspects of the empirical material while filtering out less relevant data. This enabled a more focused and systematic interpretation of the collected data (Yin, 2018).

The interview data was transcribed and subsequently coded to organize and structure the material. Coding involved assigning labels to segments of the data based on their content and meaning. This enabled the identification of key patterns and recurring aspects related to logistics planning, constraints, and coordination. The coding and categorization process was further guided by the conceptual framework presented in Figure 2.6. In addition to interview data, documents and observations were analyzed to provide further insight of the case. These data sources were reviewed and interpreted in relation to the identified patterns, contributing to a more comprehensive understanding of logistics planning and operational practices. The integration of multiple data sources enabled triangulation, strengthening the consistency and robustness of the findings.

3.6 Research Quality

Ensuring the quality of the research is an important aspect of scientific studies. This ensures the comprehensiveness, reliability, and credibility of the study, confirming that the findings are accurate and trustworthy (Yin, 2018). According to Fellows and Liu (2015), research quality in construction management research is commonly assessed through criteria such as reliability, validity, and generalisability. In case study research, these concepts are often operationalised through specific criteria including construct validity, internal validity, external validity, and reliability (Yin, 2018). These criteria are therefore used in this study to evaluate the robustness and trustworthiness of the research process.

3.6.1 Construct Validity

Construct validity refers to the extent to which the study accurately measures the concepts it intends to investigate (Yin, 2003). In order to strengthen construct validity, multiple sources were used, including interviews and project documentation from different actors. This enabled triangulation of data sources, where findings from interviews, documents, and observations were compared to ensure consistency and strengthen the credibility of the results. Furthermore, the conceptual framework developed in the literature review guided the design of the interview questions and the subsequent analysis. This was done to ensure a clear link between theoretical concepts and the empirical data collected in the study.

3.6.2 Internal Validity

Internal validity concerns the credibility of the relationships identified in the study (Yin, 2003). In this research, internal validity was addressed by comparing empirical findings with existing theoretical concepts and identifying patterns related to logistics planning, constraints, and logistics solutions. The iterative process between theory and empirical observations further contributed to strengthening the internal validity of the study.

3.6.3 External Validity

External validity refers to the extent to which the findings of a study can be generalized beyond the specific case being investigated. In case study research, the aim is not statistical generalization but rather analytical generalization, where findings are interpreted in relation to existing theory (Yin, 2018). The purpose of this study is therefore not to generalize results to all construction projects, but to contribute to the understanding of construction logistics practices and challenges within similar project contexts.

3.6.4 Reliability

Reliability refers to the extent to which the research process is transparent and can be repeated by other researchers (Yin, 2018; Fellows & Liu, 2008). To ensure reliability, the research procedures were clearly documented, including the research design, data collection methods, and analysis process. The use of a structured interview guide further contributed to ensuring consistency across interviews.

3.7 Ethical Considerations

Ethical considerations were taken into account throughout the research process. Participants involved in the interviews were informed about the purpose of the study and how the collected data would be used. Participation in the interviews was voluntary, and respondents were given the opportunity to ask questions regarding the study.

Before each interview, the participants were asked for permission to record the conversation. The recordings were used solely to ensure accurate documentation of the interviews and to allow the researcher to revisit the discussions during the analysis phase. The interviewees were also asked whether they preferred to remain anonymous in the thesis. To ensure confidentiality, all respondents have been anonymised. In the empirical findings and analysis, respondents are primarily referred to as Respondent A, Respondent B, etc., in order to preserve anonymity. In some cases, professional roles are also used when considered relevant for understanding the respondents perspective or responsibilities within the project.

4. Empirical findings

This chapter presents the empirical findings of the study, based on interviews, project documentation, and observations. The findings are primarily centred on the TBL project, while also incorporating broader experiences and reflections from respondents based on similar construction projects and industry knowledge. All quotes included in this chapter are translated from Swedish to English.

The findings are structured into four parts. First, the construction logistics context is presented, including key characteristics of the project environment and relevant industry perspectives. Second, findings related to logistics planning and constraints are described. Third, the chapter presents the identified logistics solutions and coordination practices. Finally, the chapter outlines the expected performance implications associated with the logistics setup.

4.1 Construction logistics context

Construction logistics is described by respondents as complex and difficult to coordinate, largely due to the involvement of multiple actors and the way responsibilities are distributed across the project. Rather than being centrally managed, logistics activities are often handled independently by contractors and subcontractors, each focusing on their own deliveries and operations. Several respondents emphasized that, in many construction projects, logistics is not systematically planned, but instead managed in an ad hoc manner. As a result, material flows are often not coordinated across actors, leading to limited control and challenges in managing deliveries on site. As respondent E explained, when deliveries are not actively controlled, they tend to follow default patterns rather than project-specific needs:

> "The absence of structured logistics often results in a large majority of deliveries arriving within a very limited window, specifically between 06:00 and 09:00. This concentration creates significant daily spikes in the traffic flow, and when combined with peak phases of the project, it can result in very high volumes of deliveries within a short period of time."

Several respondents reflected on the development and acceptance of construction logistics as relatively slow, despite an increased awareness of its importance within the industry. In particular, Respondent C argued that the overall level of ambition in construction remains too low, and that there is a widespread acceptance of disruptions and inefficiencies as part of normal operations. This perspective is supported by other respondents, who described the industry as still relatively immature and lagging behind more industrialized sectors, where structured processes and digital tools are more widely adopted. Despite the concept of construction logistics becoming more established, respondents emphasized that traditional ways of working remain dominant, and that change often occurs gradually. At the same time, the findings indicate that awareness of the importance of logistics is increasing, particularly in more advanced projects

where logistics is treated as a strategic function. In such cases, efforts are made to improve coordination, reduce waste, and enhance overall efficiency, often through the implementation of structured logistics solutions such as consolidation centres, third-party logistics providers, and digital logistics systems.

A recurring theme across the interviews is the central role of the client or project owner in shaping how construction logistics is planned and implemented. Several respondents emphasized that responsibility for initiating logistics does not only lie with contractors, but also with the client, particularly in the early stages of the project. In particular, Respondent E highlighted that logistics conditions and expectations should ideally be defined by the client already at the procurement stage, ensuring that requirements are clearly communicated before project execution begins:

> "It is the client, or the project owner, who needs to set the requirements at the procurement stage to achieve good logistics performance."

This perspective was supported by other respondents, who described logistics as a top-down process, where requirements defined by the client are passed on to the general contractor and subsequently to subcontractors. Furthermore, respondents argued that the client plays a decisive role in driving broader industry change. Without clear requirements and prioritization from the client, logistics is often treated as a secondary concern or an additional cost, rather than an integrated part of project planning. As Respondent D pointed out, significant improvements in construction logistics are unlikely to occur unless clients actively demand more structured approaches:

> "The major change will happen when clients start setting clear requirements. Then the rest of the industry will adapt and solve it."

Multiple respondents mean that this is particularly important in projects involving multiple contractors, where the client is often the only actor with the mandate to coordinate and enforce a common logistics strategy. At the same time, respondents also emphasized the importance of client engagement, noting that even when requirements are defined, active involvement is needed to ensure that logistics solutions are implemented and followed throughout the project.

The TBL project represents a case where construction logistics is addressed in a more structured manner. The project is carried out as a design-build partnering contract, with open books between the client and general contractor. This means that there is economical transparency between the major interested parties. Respondent J1 representing the client describes this as a way to establish "Good culture for the economy of the project, and a good dialog with the entrepreneur". This type of procurement setup was described by respondents as creating favourable conditions for integrating logistics solutions into the project, as both requirements and

associated costs are jointly defined and approved within the project organization. Respondent D emphasized that the client plays a key role in enabling such solutions, as logistics can be included as part of the overall project scope rather than being treated as an additional cost item. In contrast to more traditional procurement approaches, where logistics solutions may be excluded due to cost considerations, the TBL project allows for project-adapted logistics arrangements to be implemented from an early stage. Respondents further noted that this creates conditions for testing and evaluating logistics solutions in practice, as both the operational setup and economic framework are clearly defined within the project.

In the TBL project, the empirical findings further illustrate how construction logistics is shaped by the interaction between multiple actors with different roles and responsibilities. While the client defines the overall requirements and conditions, the general contractor is responsible for coordinating logistics activities, supported by external logistics providers and dedicated roles within the project. Respondents described how this setup requires continuous interaction between actors, both in terms of planning and daily operations, particularly in a constrained environment such as an active hospital area. At the same time, several respondents emphasized that challenges often arise when responsibilities are unclear or when actors have different planning horizons and priorities. This highlights the importance of aligning actors and establishing clear structures for how logistics should be managed within the project. These conditions form the basis for the constraints affecting logistics planning and execution, which are further explored in the following section.

4.2 Logistics planning and constraints

Building on the construction logistics context presented in the previous section, the empirical findings highlight a number of constraints that significantly influence how logistics is planned and executed in the TBL project. These constraints stem both from the project environment and from the organization of construction activities. Respondents emphasized that logistics planning is largely shaped by these conditions, requiring structured approaches to manage material flows, deliveries, and on-site operations. This section first presents the key constraints identified in the project, followed by how these are addressed through logistics planning and formalized in the project's construction logistics plan.

4.2.1 Constraints

The empirical findings indicate that construction logistics in the TBL project is strongly shaped by a range of constraints related to both the project environment and the organization of activities. Respondent H emphasized that, while the project is not considered strategic for them in terms of size, it is still highly complex due to the conditions under which it is carried out. Respondents consistently highlighted that these constraints significantly limit flexibility in logistics operations and require a high degree of planning and coordination. In particular, the

combination of restricted access, limited space, and the need to operate alongside ongoing hospital activities reduces the ability to handle deliveries and material flows in an ad hoc manner. As a result, logistics activities must be aligned in advance, as there is limited opportunity to adjust deliveries, reallocate resources, or manage disruptions once operations are underway. Several respondents further emphasized that these conditions increase dependencies between activities, where even small deviations in deliveries or resource availability can quickly affect other parts of the project. At the same time, respondents contrasted this with more conventional construction projects, where greater spatial flexibility and fewer external constraints allow for deliveries to be handled more informally, with the possibility to store materials on site, adjust plans during execution, and manage disruptions as they occur.

A key characteristic of the TBL project is its location within an active hospital environment, where construction activities take place alongside ongoing healthcare operations. Respondents consistently described this setting as highly restrictive and disturbance-sensitive, as logistics must be managed without interfering with critical functions such as ambulance access, patient transport, and daily hospital operations. Several respondents emphasized that the hospital operates continuously, creating constant flows of emergency vehicles, staff, patients, and service operations that construction logistics must adapt to. As highlighted by Respondent J2, ambulance routes and emergency access must remain unobstructed at all times, meaning that construction traffic cannot occupy surrounding roads or wait outside the site. In this context, Respondent I described the implications of logistics failures as potentially “a matter of life and death” if access routes are blocked.

In addition to the operational constraints of the hospital environment, respondents described the physical conditions of the site as highly restrictive. The construction areas are characterized by extremely limited space, with barely any available areas for on-site material storage. As described by respondents, the construction site is effectively constrained to the building footprint, leaving no room for traditional logistics practices such as buffering or temporary storage. Several respondents emphasized that the level of spatial restriction is significantly higher than in conventional projects, where some degree of flexibility is often available. Respondent H described the project as being “shoehorned” into the existing environment, highlighting that there is no excess space available and that the project operates under highly compact conditions. Other respondents noted that site boundaries are positioned directly adjacent to building facades, which means that there is barely any possibility to temporarily expand the site or create additional space for logistics activities. This lack of space also limits the use of standard equipment and handling methods, as machinery and vehicles often lack sufficient turning radius within the site. Respondents also noted that it is not feasible to have equipment such as loaders or dedicated unloading resources continuously available on-site due to the space constraints.

Furthermore, the surrounding infrastructure contributes to the logistical challenges, as access roads within the hospital area were described as narrow and difficult to navigate. Thus requiring careful management of vehicle movements both on-site and in the surrounding area. Respondents also emphasized that access to the site is restricted through a limited number of entry points, where each construction area is typically served by a single gate, creating bottlenecks for all incoming deliveries. In addition, respondents highlighted that the project is divided into separate work areas with varying physical conditions, where some areas allow slightly more flexibility while others are significantly more constrained, further increasing the complexity of logistics operations. Overall, the constraints identified in the TBL project relate to limited space, restricted access, and the need to operate within an active and disturbance-sensitive environment. These constraints affect both off-site and on-site logistics activities, influencing how deliveries are planned, coordinated, and executed. The key constraints identified in the empirical findings are summarized in Table 4.1.

Table 4.1: Key constraint findings

On/off-site	Constraint	Description
Off-site	Strict delivery scheduling requirements	Deliveries must be precisely timed due to access restrictions and lack of waiting areas
Off-site	Ongoing hospital operations	Construction takes place in an active hospital environment with critical functions
Off-site	No-waiting policy	Vehicles are not allowed to queue outside due to emergency routes
On-site	Gate availability	Two main gates available (one per work area) for all incoming deliveries
On-site	Limited on-site vehicle capacity	Only one delivery vehicle allowed on-site at a time
On-site	Site space limitation	Limited available space for material storage and handling within the construction site
On-site	Equipment and vertical transport resources	Limited number of equipment and construction hoists shared between activities

Overall, the constraints summarized in Table 4.1 illustrate how both off-site and on-site conditions jointly limit the flexibility of logistics operations in the TBL project. Respondents emphasized that these constraints do not occur in isolation, but rather interact and reinforce each other, creating a logistics environment where small disruptions can have cascading effects across activities. As a result, the need for structured planning becomes central, as logistics activities must be carefully coordinated in advance to ensure that deliveries, resource allocation, and site operations are aligned with the limited capacity available. This highlights the importance of proactive logistics planning, which is further explored in the following section.

4.2.2 Logistics planning

The empirical findings indicate that logistics planning in the TBL project is closely linked to the early identification of constraints and the need to proactively manage the conditions under which the project is carried out. Several respondents emphasized that logistics planning must begin with a structured logistics analysis conducted in the early stages of the project. Respondent E highlighted that this analysis is ideally performed already during procurement, where key limitations related to infrastructure, access conditions, and surrounding activities can be identified before major decisions are finalized. This early analysis was described as essential for understanding how the project environment affects material flows, enabling the identification of potential bottlenecks and delivery peaks. Other respondents supported this view, emphasizing that early logistics analysis allows the project to estimate expected delivery volumes, assess capacity limitations, and evaluate logistics setups, such as the need for consolidation solutions or external control points. In the context of the TBL project, this type of analysis was described as particularly important due to the highly constrained hospital environment, where limited flexibility requires that logistics decisions are defined in advance rather than adjusted during execution.

Respondents further highlighted that early logistics planning also plays a critical role in shaping other aspects of the project. In addition to identifying constraints, the analysis phase supports decisions related to site layout, resource allocation, and the design of material flows throughout the project lifecycle. Several respondents emphasized that without this early planning, logistics is often handled reactively, leading to inefficient flows and increased risk of disruptions during production. In contrast, projects where logistics is integrated early are better equipped to align deliveries, manage activities, and avoid unnecessary handling of materials. In the TBL project, respondents described how the early focus on logistics enabled a more structured approach to managing deliveries and coordinating actors, which was seen as necessary given the lack of buffering capacity and the high level of dependency between activities. Building on this early analysis, respondents described logistics planning as a structured process requiring several key elements to be in place. Respondent D outlined a set of fundamental “hygiene factors” that form the basis for effective logistics planning across construction projects:

1. Logistics analysis and logistics plan: Planning should begin in the tender phase, where the project defines how deliveries, material handling, and site constraints are managed.
2. Dedicated roles: The project requires clearly defined logistics roles, including logistics planners in early phases and logistics manager during production.
3. Multi-level site layout planning: Planning should address external conditions, on-site logistics, and internal material flows within the building.
4. Meeting structures: Logistics must be continuously coordinated through structured meetings where upcoming deliveries and activities are aligned.
5. Delivery planning and time-slot booking: Deliveries must be planned and booked in advance to manage limited capacity and reduce variability in material flows.

These factors were described as forming a baseline for how logistics planning should be organized, ensuring that both strategic and operational aspects are addressed throughout the project. Respondents emphasized that the absence of these elements often leads to fragmented planning, where logistics becomes reactive rather than proactive. In the TBL project, several of these planning principles were reflected in how logistics activities were organized during the planning phase and early production, where planning is carried out across multiple time horizons, with long-term schedules continuously refined into more detailed short-term plans. To support this process, respondent K highlighted the use of structured coordination practices, where visual planning production is applied as a recurring meeting format in which project actors jointly review upcoming activities, deliveries, and resource needs. These meetings involve key roles such as site management, supervisors, and the logistics manager, and are used to align short-term plans with the constraints of the project, with logistics treated as a standing agenda item. Within this process, logistics was described as a governing factor for production planning, as activities must be aligned with the limited capacity for deliveries, access, and shared resources. Several respondents further emphasized the importance of discipline in following planned delivery schedules, noting that deviations are difficult to manage due to the constrained environment. As a result, logistics planning is closely linked to continuous coordination practices, where upcoming deliveries, resource availability, and site conditions are regularly reviewed, with the logistics manager playing a central role in ensuring that planning decisions are implemented and that communication between actors is maintained.

Another recurring theme in the empirical findings is that logistics planning extends beyond the physical construction site and includes the entire supply chain, from procurement to installation. Respondents emphasized that traditional construction logistics often focuses primarily on activities within the site boundaries, whereas more advanced approaches require visibility across the full material flow. In the TBL project, this broader perspective was described as important for identifying potential disruptions in advance. Digital systems were highlighted as key enablers in this process, allowing project actors to monitor planned deliveries, coordinate shared resources, and adjust plans proactively rather than reacting to problems as they occur. The findings indicate

that logistics planning in the TBL project is characterized by a structured and forward-looking approach, where early analysis, defined processes, and continuous planning are used to manage the constraints of the project.

4.2.3 Construction logistics plan

Building on the structured planning process described above, respondents highlighted the construction logistics plan as the key mechanism through which logistics strategies are translated into concrete rules and procedures within the project. Rather than being a high-level document, the CLP in the TBL project was described as a detailed and operational framework that defines how logistics activities should be executed in practice. Several respondents emphasized that the CLP is developed based on the early logistics analysis and the identified constraints, meaning that the document reflects the specific conditions of the project, including limited space, restricted access, and the need to coordinate with ongoing hospital operations. In this sense, the CLP was described as a direct continuation of the planning phase, where identified limitations and chosen logistics solutions are formalized into a structured set of guidelines that all actors must follow.

In the TBL project, the CLP was described as highly structured and covering multiple aspects of logistics operations. Respondents highlighted that the plan includes detailed specifications regarding delivery management, such as mandatory time-slot booking through a shared booking system, and clear procedures for how deliveries are handled upon arrival. Furthermore, the CLP defines how different logistics setups should be used, including the use of consolidation terminals, checkpoint solutions, and direct deliveries, depending on the type of material and delivery conditions. In addition, the plan specifies requirements for material handling, including goods labelling, allocation of unloading resources, and internal transport to the point of installation. Several respondents emphasized that the level of detail in the CLP is necessary due to the constrained environment. Another important aspect emphasized by respondents is that the CLP functions as a coordinating and governing tool across all project actors. By clearly defining roles, responsibilities, and expected behaviours, the plan creates a shared understanding of how logistics should be managed throughout the project. At the same time, the CLP was described as closely linked to procurement and project governance, as it is introduced early in the project and communicated to contractors to ensure that logistics requirements are understood and integrated into their operations. Overall, the findings indicate that the CLP in the TBL project functions as a central instrument for aligning planning with execution, ensuring that logistics activities are carried out in a consistent and controlled manner.

4.3 Logistics setup and coordination

The empirical findings indicate that the logistics solutions implemented in the TBL project are closely linked to the constraints and planning conditions described in the previous sections.

Logistics was described as a central and governing function, where specific solutions were required to ensure both efficient construction operations and minimal disruption to surrounding activities. Several respondents highlighted that the selection of logistics solutions was not based on isolated decisions, but rather on a structured process where early logistics analysis, project-specific constraints, and client requirements jointly shaped the overall setup. In this process, particular emphasis was placed on controlling material flows, reducing the number of on-site deliveries, and increasing predictability in logistics operations. As a result, the project implemented a set of interrelated solutions designed to manage both the physical and organizational complexity of the project environment. The findings further show that these solutions are closely interconnected and rely on each other to function effectively. Rather than acting independently, they form a coordinated logistics system where digital tools, external logistics operations, on-site management, and material handling practices are aligned to manage limited capacity and high dependencies between activities. The following sections present the key logistics solutions identified in the empirical material and describe how they are applied within the TBL project.

4.3.1 Digital delivery management system

The empirical findings highlight the digital delivery management system as a central component of the logistics setup in the TBL project. Respondents consistently described the system as a key enabler for managing the constrained logistics environment. In the TBL project, the system is implemented as a cloud-based platform, accessible through both desktop and mobile devices, allowing project actors to plan, monitor, and coordinate logistics activities regardless of location. While the mobile application provides more limited functionality, it enables actors on-site to access and update critical information in real time. The core function of the system is the delivery scheduling module. All deliveries must be registered and assigned a specific time slot in the system before arriving at the site. Respondents emphasized that this shared delivery calendar creates a common overview of incoming material flows, enabling project actors to book deliveries according to available capacity, such as unloading zones, cranes, and internal transport resources. In the TBL project, this function was described as essential for avoiding congestion and conflicts, particularly given the restrictions on vehicle queuing and the limited number of access points. By making delivery information visible to all actors, the system allows for early identification of potential bottlenecks, supporting a more proactive approach to logistics coordination. As respondent C described, the system enables project actors to “act instead of react” by identifying capacity issues in advance and adjusting delivery schedules accordingly.

In addition to delivery planning, respondents highlighted the systems role in managing shared resources and material flows across the project. The system is used for the booking of critical resources such as cranes and hoists, ensuring that these are allocated efficiently and not double-booked. Furthermore, it supports material tracking and information sharing across the supply chain, from suppliers and external logistics operations to on-site handling. This creates a

higher level of transparency, where actors can monitor the status of deliveries and align their activities with material availability. Several respondents emphasized that this visibility is particularly important in the TBL project, where disruptions cannot easily be absorbed due to the lack of space and flexibility. Respondent A also mentioned the system's capability to generate data for performance measurement and follow-up as an important feature. By capturing detailed information on deliveries, resource usage, and booking behaviour, the system enables the monitoring of key performance indicators related to logistics operations. Examples mentioned by respondents include delivery precision, the number of days in advance deliveries are booked, and the share of consolidated deliveries handled through external logistics solutions.

At the same time, the findings indicate that the effectiveness of the digital system is highly dependent on consistent use and adherence to established procedures. Respondents noted that the system is used not only as a planning tool, but also as a mechanism for enforcing discipline in logistics operations. In practice, deliveries that are not registered or do not follow the assigned time slots may be rejected, reflecting the need for strict coordination in the project. The findings suggest that the digital delivery management system functions as a central platform in the TBL project, enabling transparency, resource alignment, and proactive control of material flows under highly restrictive conditions.

4.3.2 Third party logistics solution

The findings indicate that AkkaFrakts 3PL services plays a central role in the TBL projects off-site logistics, as well as reducing the need for on-site storage. Respondents described the 3PL solution as a way of partly relocating logistics activities outside the construction site in order to reduce complexity on-site. In this setup, the 3PL provider is responsible for managing material flows before they reach the construction site, including consolidation, storage, and delivery coordination. A key component of the 3PL solution is the use of an external terminal, which functions as a buffer and control point for incoming materials. Instead of all suppliers delivering directly to the construction site, materials are first transported to the terminal, where they are checked, stored, and consolidated when possible. Respondents emphasized that this enables a higher degree of control over delivery timing, while also allowing for increased load utilization through consolidated transports. By consolidating multiple deliveries into fewer, fully loaded vehicles, the respondents mean that the number of transports entering the hospital area can be significantly reduced.

In addition to the terminal, respondents highlighted the use of an external checkpoint as a critical element for controlling direct deliveries that cannot be handled through consolidation. All such deliveries are required to pass through this control point before accessing the construction site, where they are verified against planned time slots and coordinated with current site conditions. This was described as essential not only for enforcing the no-waiting policy, but also for regulating the inflow of vehicles based on the site's ability to receive them. In this sense, the

checkpoint functions as an off-site buffer, where deliveries are held and released in alignment with available unloading capacity and internal resources. Together, the terminal and checkpoint functions create a controlled inflow of materials, where deliveries are released to the site only when they can be handled without causing disruption. In addition, respondents described how deliveries handled through the 3PL solution are, to a large extent, scheduled outside of regular production hours. This arrangement, agreed upon between the project and the 3PL provider, enables material to be delivered and pre-handled on-site before next day production activities begin. The coordination of these deliveries is mentioned to be managed in close collaboration with the logistics manager and on-site material handling staff. The 3PL solution further enables the use of external storage facilities for long-term material handling, allowing contractors to procure materials in larger volumes and store them off-site until needed. Respondents noted that this reduces the need for on-site storage while also creating opportunities for more cost-efficient procurement. In addition, the 3PL setup supports integrated material handling and waste management, where transport flows are optimized by combining deliveries and removal of waste materials. This integrated approach was described as beneficial in the TBL project, where limited space and high coordination requirements make it necessary to minimize unnecessary movements and handling on-site. Overall, the findings indicate that the 3PL solution functions as a key mechanism for relocating complexity away from the construction site, enabling more controlled, efficient, and predictable logistics operations.

4.3.3 Logistics manager

The empirical findings indicate that the logistics manager plays a central role in enabling coordination across actors and logistics functions in the TBL project. Respondents consistently described the role as critical in managing the complexity created by the project's constraints, particularly in ensuring that deliveries, resources, and activities are aligned with the limited capacity of the site. In this context, the logistics manager was described as acting as the central point of contact, responsible for connecting different actors and maintaining an overview of ongoing and upcoming logistics activities. A key aspect of the role is to ensure that logistics planning is translated into operational practice. Respondents emphasized that, in contrast to more conventional projects where logistics responsibilities are often distributed across different roles, the TBL project relies on a dedicated logistics manager who oversees delivery bookings, resource allocation, and site access. This includes verifying deliveries in the digital system, coordinating with the 3PL provider, and ensuring that deliveries are aligned with available unloading capacity and internal site conditions. Several respondents highlighted that the logistics manager plays an important role in enforcing discipline in the use of the logistics system, where deliveries that are not properly booked or scheduled may be rejected in order to avoid disruptions.

The role was further described as essential for coordinating shared resources and preventing conflicts between activities. Given the limited availability of equipment such as cranes, hoists,

and unloading zones, the logistics manager is responsible for prioritizing and allocating these resources across different contractors. The role also bears the responsibility of ensuring that the required unloading equipment is arranged in connection with planned deliveries. As such resources are not permanently available on-site but must be booked in advance from external providers. Respondents emphasized that this function reduces the risk of overlapping activities and ensures that available capacity is used efficiently. In addition, the logistics manager was described as playing a key role in facilitating communication between actors, acting as a central point of contact for contractors, logistics providers, and the client. This was highlighted as particularly important in the hospital setting, where the logistics manager also functions as an interface between construction logistics and the hospital's own operational flows, ensuring that deliveries and transport activities do not interfere with critical functions such as patient transport or service operations.

Finally, respondents emphasized the importance of the logistics manager in enabling a proactive rather than reactive approach to logistics management. By maintaining an overview of planned deliveries and resource usage, the logistics manager can identify potential bottlenecks in advance and adjust plans before disruptions occur. This was described as a key factor in managing the high level of interdependencies within the project. Overall, the findings indicate that the logistics manager functions as a central coordinating mechanism in the TBL project, ensuring that logistics activities are aligned, controlled, and adapted to the constraints of the project environment.

4.3.4 On-site material handling

On-site material distribution in the TBL project is organized as a dedicated service applied to selected deliveries, primarily those routed through the 3pl. These deliveries are planned to be handled by specialized personnel, who transport materials from the unloading point to their designated locations within the building. Respondents described this approach as necessary due to the limited space on-site. Instead, materials are moved directly to predefined locations close to their point of use, reducing the need for intermediate handling and limiting the presence of materials in shared workspaces. As described by Respondent D, the intention is that materials should be placed in position in advance, reducing the need for construction workers to carry or relocate materials themselves during production. A key characteristic of this solution is that internal material transport activities are planned to take place outside regular working hours. Several respondents explained that these activities are meant to be performed in the late afternoon or evening, after the main construction work has ended. This approach was described as a way to avoid competition for shared resources such as hoists, corridors, and internal access routes, which are otherwise heavily utilized during daytime operations. By shifting these activities to off-peak periods, dedicated logistics personnel can operate with fewer constraints and reduced interference with both construction work and hospital operations. At the same time, respondents noted that this separation in time allows unloading capacity during daytime to be

used more efficiently for incoming direct deliveries, rather than being occupied by internal material movements.

Respondents further emphasized that this approach supports a more structured use of the limited on-site space, where materials are placed according to predefined layout plans and aligned with ongoing activities. In the TBL project, this was described as particularly important due to the constrained environment, where poorly planned material placement can quickly obstruct access routes and disrupt workflows. Respondent D further added that each time material needs to be moved, the risk of injury or damage to the materials is increased. The use of dedicated personnel for this activity also ensures that appropriate equipment and planned handling methods are applied, rather than relying on ad hoc solutions. In this context, on-site material distribution was described as closely integrated with delivery planning and site operations, ensuring that materials are positioned in a controlled manner without creating additional congestion within the project environment.

4.4 Expected performance implications

The empirical findings indicate that the logistics solutions implemented in the TBL project are expected to address several of the operational challenges identified in the project, particularly those related to limited space, restricted access, and high coordination requirements. Respondents described these solutions as primarily aimed at reducing disruptions, improving control over material flows, and enabling a more predictable production process. While many of the measures are introduced as a response to constraints, several respondents also emphasized that they create conditions for improved efficiency in the project. One of the most frequently highlighted implications concerns the reduction of transport volumes and improved control of deliveries. Respondents described how the use of consolidation and transport planning enables a significant decrease in the number of vehicles entering the site. In particular, the 3PL provider estimated that consolidation can reduce the number of transports by at least 50 percent for applicable deliveries. This was described as important not only for reducing congestion around the site, but also for maintaining access to critical infrastructure such as emergency routes. In addition, the structured delivery system and use of time-slot booking were described as contributing to a more even distribution of deliveries over time, reducing peaks in inflow and lowering the risk of disruptions.

Respondents also highlighted expected improvements related to productivity and the use of resources. By coordinating deliveries, allocating shared resources through digital systems, and organizing internal material transport separately from production activities, the logistics setup was described as reducing non-value-adding activities for the construction workers. In this context, respondent A referred to experiences from similar projects, where structured logistics solutions have been associated with productivity improvements of around 25 percent. Primarily due to reduced time spent on material handling and searching for materials. While such

outcomes have not been measured directly in the TBL project, respondents described similar expectations regarding the ability to perform construction activities more efficiently. In addition to efficiency-related aspects, respondents emphasized the role of logistics solutions in minimizing risks and improving safety. Material handling and uncoordinated deliveries were described as major sources of risk in construction projects. Respondent D emphasised this by saying:

> "Around 50% of all construction site injuries can be connected to material handling"

By introducing structured delivery planning, dedicated handling processes, and controlled access to the site, the logistics setup is expected to reduce the likelihood of accidents, as well as the risk of disruptions to surrounding hospital operations. Overall, the findings suggest that the expected performance implications of the logistics setup in the TBL project relate to increased control, reduced variability, and improved alignment between logistics and production activities. While the solutions are primarily implemented to manage constraints, respondents emphasized that they also create opportunities for improved efficiency, reduced waste, and more stable project execution.

5. Analysis

This chapter presents the analysis of the study by synthesizing the empirical findings with the theoretical framework. The purpose is to interpret the results and develop a deeper understanding of how construction logistics is planned, implemented, and managed in complex project environments. The chapter is structured into five parts. First, the role of constraints in shaping construction logistics is analysed. Second, planning is examined as a mechanism for control and coordination. Third, the governance role of the construction logistics plan is discussed. Fourth, the logistics setup is analysed as an integrated system. Finally, the performance implications and trade-offs of the logistics approach are evaluated.

5.1 Managing constraints in construction logistics

The findings indicate that construction logistics in the TBL project is fundamentally shaped by a set of interrelated constraints that significantly reduce operational flexibility and increase the need for structured coordination across activities. Rather than representing isolated limitations, these constraints collectively form a tightly controlled logistics system in which traditional, ad hoc approaches to material handling and delivery management are no longer viable. This stands in contrast to more conventional construction projects, where greater spatial flexibility and the presence of on-site buffering capacity allow for more reactive and decentralized logistics practices (Seppänen & Peltokorpi, 2016). In the TBL context, however, the combination of limited space, restricted access, and the requirement to operate alongside ongoing hospital activities creates conditions where deviations in deliveries or resource allocation cannot easily be absorbed, thereby increasing the sensitivity of the system to disruptions. This reflects characteristics commonly associated with construction supply chains, where interdependencies between activities and limited integration across actors contribute to cascading effects when disruptions occur (Vrijhoef & Koskela, 2000; Dubois & Gadde, 2002b).

To further structure the analysis, the identified constraints can be categorized into five main dimensions: environment, spatial, access, resource, and process (see Figure 5.1). These dimensions illustrate that the limitations affecting logistics operations originate from both external conditions, such as the surrounding environment, and internal site characteristics, such as layout and resource capacity. Importantly, the constraints do not act independently but reinforce one another, creating a system characterized by limited capacity, restricted maneuverability, and a high degree of vulnerability to disruptions. While the intensity of these conditions is particularly pronounced in the TBL project due to the hospital setting. There are similar patterns that can be observed in other dense and infrastructure-constrained construction environments as limited space and external dependencies increase the importance of joint planning (Ekeskär & Rudberg, 2016). The fishbone diagram below provides a structured overview of the key constraints identified in the TBL project. It serves to illustrate how different

categories of constraints collectively shape logistics operations and contribute to the complexity of the system.

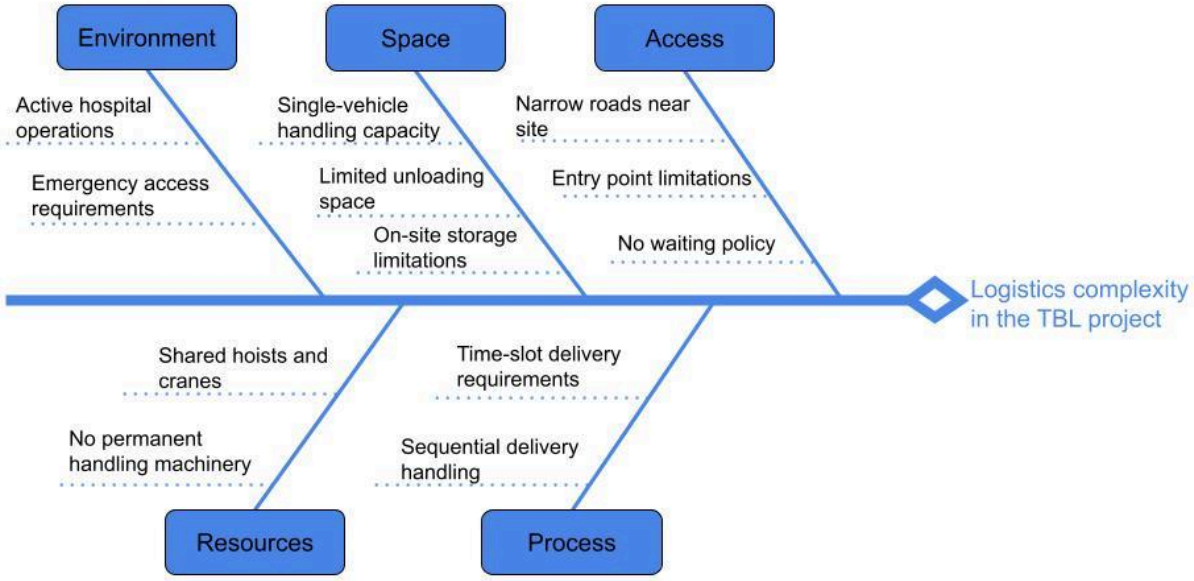

Figure 5.1: Fishbone diagram illustrating factors contributing to logistics complexity in the TBL project

The identified constraints highlight how construction logistics in the TBL project is characterized by a high degree of interdependency between activities. While upstream supply processes can operate relatively independently, on-site operations are tightly coupled and highly sensitive to coordination failures (Dubois & Gadde, 2002b). In this context, limited space, restricted inflow capacity, and shared resources require deliveries and production activities to be closely aligned. This reduces the systems ability to absorb disruptions, meaning that even small deviations in delivery timing or resource availability can quickly propagate across the project. Such cascading effects are well documented in construction supply chains, where tightly interconnected activities increase vulnerability to disruptions (Naz & Fredriksson, 2023; Peiris et al., 2023). Furthermore, the combination of an active hospital environment, limited storage capacity, and strict access conditions reinforces characteristics associated with complex, uncertain, and quick supply chains (Wegelius-Lehtonen, 2001). The absence of buffering mechanisms, such as on-site storage or waiting areas, further limits the systems ability to manage variability, increasing exposure to both internal and network-related risks (Jüttner et al., 2002).

These conditions also indicate a shift from traditional buffer-based logistics towards a more flow-oriented approach, consistent with principles of lean construction. In conventional projects, buffers such as on-site storage or flexible delivery practices are often used to manage uncertainty. In the TBL project, however, such buffers are largely absent on site due to spatial constraints, requiring material flows to be tightly controlled and aligned with actual production needs. This reflects elements of a pull-based approach, where deliveries are coordinated based on site

readiness rather than predefined schedules (Kalsaas et al., 2015). While this can reduce waste and unnecessary handling, it also increases reliance on precise planning and disciplined execution, as the system becomes less tolerant to variability. The findings further suggest that flexibility is reduced on the construction site itself due to limited space and restricted buffering possibilities. Instead, the responsibility for handling variability and unforeseen events is shifted upstream towards the 3PL provider and logistics system

5.2 Planning as a mechanism for control and coordination

The findings indicate that logistics planning in the TBL project functions as a central mechanism for both control and coordination across the construction process. Rather than being confined to a single phase, planning evolves throughout the project lifecycle, linking early project requirements with operational execution. This reflects a more proactive approach, where material flows and resource allocation are actively shaped in advance rather than adjusted during production (Ballard, 2000; Sundquist et al., 2018). In this context, planning is not only concerned with defining activities, but also with ensuring that the necessary conditions are in place for these activities to be executed as intended. In the TBL project, this approach to planning is closely connected to the project's constrained environment and the requirements established in early project stages. The empirical findings show that logistics considerations were introduced already during the tendering process, where contractors were required to demonstrate how logistics could be managed under the given conditions. These early requirements were shaped by the client's need to ensure operational continuity within an active hospital environment, where disruptions to surrounding activities must be avoided. This highlights the importance of early logistics planning, as logistics solutions need to be considered in early project stages to ensure alignment between logistics strategies and overall project requirements (Ekeskär & Rudberg, 2016). As a result, logistics planning becomes embedded in both procurement decisions and subsequent project planning, influencing how material flows, responsibilities, and logistics processes are structured. To illustrate this progression, Figure 5.2 presents a conceptual model of logistics planning across four stages: pre-study, procurement, pre-planning, and continuous planning during project execution. The model highlights how logistics planning develops from the identification of constraints and requirements, through contractual and organizational structuring, to detailed system design and ongoing management during execution.

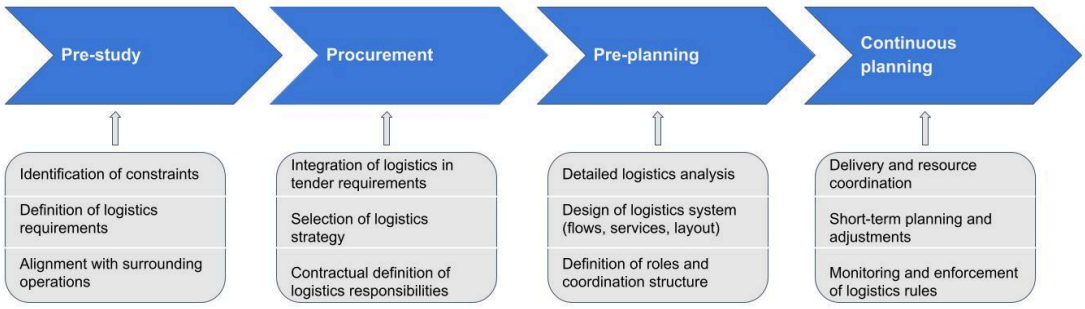

Figure 5.2: Conceptual model of logistics planning across project stages

5.2.1 The role of procurement in enabling logistics planning

The findings indicate that procurement plays a critical role in enabling structured logistics planning by shaping both the organizational conditions and the economic framework within which logistics solutions are developed. In the TBL project, the use of a design-build partnering contract creates a context where logistics is not treated as a separate support function, but rather as an integrated component of the overall project delivery. Unlike other procurement forms, where logistics solutions may be excluded or down-prioritized due to cost considerations, the partnering setup enables joint decision-making between the client and general contractor. Supported by economic transparency through open-book arrangements. This creates conditions where logistics requirements and associated costs can be defined and accepted early in the project, thereby facilitating the implementation of project-adapted logistics solutions. From a theoretical perspective, this aligns with characteristics of design-build procurement, where the integration of design and construction enables earlier consideration of supply chain and logistics aspects (Walker & Lloyd-Walker, 2015; Sacks, 2013). Early contractor involvement allows logistics to be incorporated into decisions related to procurement schedules, resource allocation, and material flows, rather than being addressed reactively during production. At the same time, the partnering dimension introduces elements of relational governance, where trust, transparency, and joint problem-solving support collaboration across actors (Nyström, 2005; Walker & Lloyd-Walker, 2015). In combination, these features reduce fragmentation and improve information sharing, which are otherwise common barriers to effective construction logistics (Vrijhoef & Koskela, 2000). However, while the partnering setup creates favourable conditions for collaboration and integrated decision-making, the extent to which these benefits are fully realized remains uncertain. Previous research highlights that project partnering, unlike strategic long-term partnerships, may struggle to establish the level of trust and shared understanding required for effective coordination within a single project (Kadefors et al., 2004). As such, although the TBL project includes formal mechanisms intended to support collaboration, such as joint meetings, open-book arrangements, and shared project offices, these do not automatically guarantee deep collaboration. Instead, the effectiveness of the setup depends on how actively these structures are used to align actors and manage interdependencies in practice. This suggests that while procurement establishes the potential for integrated logistics planning, the actual realization of these benefits depends on how effectively project actors collaborate and utilize the structures established through the partnering arrangement.

The empirical findings further suggest that procurement also influences how logistics solutions affect downstream actors, particularly subcontractors. By defining logistics services as part of the project scope, responsibilities for material handling and coordination are centralized rather than left to individual contractors (Sundqvist et al., 2018). This could create conditions where subcontractors can adjust their bids accordingly, as they no longer need to account for certain logistics activities within their own operations. As a result, logistics planning at the procurement stage not only enables control and management of material flows but also contributes to a

redistribution of responsibilities and costs across the supply chain. This reflects a shift towards more integrated supply chain management, where logistics is used as a mechanism to align incentives.

5.2.2 Pre-planning and logistics analysis

The findings indicate that pre-planning and logistics analysis play a critical role in translating the conditions established during procurement into a structured and executable logistics system. In the TBL project, this phase is not limited to defining activities, but rather focuses on understanding how constraints, material flows, and resource capacities interact across the supply chain. The empirical findings show that logistics analysis was initiated early in the project, already during the tendering stage, and further refined once the contractor is engaged. This early focus enables the identification of bottlenecks, delivery peaks, and capacity limitations before production begins. From a theoretical perspective, this reflects the importance of integrating logistics into early planning stages to avoid inefficiencies and disruptions at the interface between the supply chain and the construction site (Naz & Fredriksson, 2023; Ekeskär & Rudberg, 2016). Rather than treating logistics as a downstream activity, pre-planning in the TBL project demonstrates a shift towards aligning material flows with project conditions from the outset.

The pre-planning phase can also be analysed through the four roles of construction supply chain management proposed by Vrijhoef and Koskela (2000). At a fundamental level, the logistics analysis in the TBL project primarily supports the first role, focusing on improving site efficiency by ensuring more reliable material flows and reducing disturbances in production. This is evident in the strong emphasis on constraint identification, delivery planning, and management of site resources. While the project also introduces elements that extend beyond a purely site-focused perspective, the extent of this shift is more limited. The choice of terminal solutions, external storage, and checkpoint functions indicates an intention to relocate certain logistics activities away from the construction site, which aligns with the third SCM role. However, these solutions do not fully replace direct deliveries, and a significant share of material flows still depend on traditional supply chain structures. As such, the transfer of activities upstream remains partial rather than fully realized. Similarly, although the project demonstrates an increased focus on coordinating material, information, and resource flows across actors, this does not necessarily imply full supply chain integration. The logistics system creates shared interfaces and improves visibility, but many actors, particularly subcontractors, remain only indirectly integrated into the system. This indicates that the project approaches aspects of the fourth SCM role, where the construction site is treated as part of a broader system, but does not fully achieve it in practice. In addition, early logistics analysis in the TBL project also reflects elements associated with the extended SCM perspectives discussed in previous research. The emphasis on defining roles, resources management, and structuring logistics processes prior to execution indicates an intention to organize the construction site as an integrated logistics

domain (Ekeskär & Rudberg, 2016). At the same time, the strong focus on external constraints, particularly the need to coordinate construction activities with ongoing hospital operations, suggests that logistics planning extends beyond the project boundary and must be aligned with surrounding societal functions (Fredriksson et al., 2021). However, at this stage, these aspects remain primarily conceptual, with their practical realization dependent on how logistics plans, responsibilities, and procedures are implemented throughout the production phase.

This is where the hygiene factors identified in the empirical findings become analytically important. They are not only practical planning elements, but represent different mechanisms for increasing supply chain integration. The logistics analysis and multi-level APD planning help connect external constraints, site layout, and internal material flows. Dedicated logistics roles reduce the risk that logistics responsibilities are fragmented between production actors. Meeting structures and delivery planning create recurring interfaces where material flows, resource needs, and production activities can be aligned. Together, these factors address several of the coordination problems associated with fragmented construction supply chains, where actors otherwise tend to optimize their own activities rather than the performance of the project as a whole (Morel et al., 2020; Vrijhoef & Koskela, 2000). By defining logistics processes early and establishing clear interfaces between actors, the project can reduce uncertainty and improve visibility of material flows. This is critical in interdependent systems where delays can propagate across activities (Dubois & Gadde, 2002b; Naz & Fredriksson, 2023). In this context, pre-planning also reflects elements of lean construction, where the identification and removal of constraints prior to execution improves workflow reliability and reduces non-value-adding activities (Ballard, 2000).

However, while the pre-planning phase establishes structured mechanisms for coordination and integration, the extent to which all actors are actively involved in this process remains limited. In particular, subcontractors are largely absent from the early logistics analysis and system design, despite being key actors in the execution of material flows. Previous research highlights that such top-down implementation of logistics solutions may lead to resistance, as subcontractors are often required to adapt to predefined systems without having been involved in their development (Sundquist et al., 2018; Fredriksson et al., 2025). This can create a disconnect between system design and operational practices, where subcontractors perceive logistics requirements as restrictive rather than enabling. From a supply chain perspective, this reflects a partial integration, where coordination mechanisms are established at a system level, but not fully embedded across all actors (Vrijhoef & Koskela, 2000). As a result, while pre-planning reduces fragmentation structurally, behavioural and organizational fragmentation can persist in later stages of the project.

In addition to supporting coordination, pre-planning also shapes the design of the logistics system itself. Decisions related to site layout, delivery structures, and the use of external logistics

solutions are defined based on the outcomes of the logistics analysis, linking strategic planning with operational execution. This highlights how logistics in the TBL project extends beyond the construction site and encompasses the entire supply chain, from procurement to installation. As a result, logistics planning becomes a cross-functional activity that integrates multiple actors and processes rather than being confined to site-level operations. As part of this phase, the logistics setup is formalized in project-specific documentation, such as a CLP, which describes how logistics activities are to be performed and coordinated throughout the project.

5.2.3 Continuous planning and coordination

While pre-planning establishes the structure of the logistics system, continuous planning determines whether this structure can be maintained under dynamic production conditions. The findings indicate that logistics planning in the TBL project evolves into an ongoing coordination process, where plans are continuously refined across different time horizons. Long-term schedules are gradually broken down into short-term and highly detailed plans, often within a 3–4 week horizon, where activities, deliveries, and resource allocations are aligned with actual site conditions. This approach reflects the principles of the Last Planner System (Ballard, 2000), where planning moves from what should be done to what can and will be done, based on the removal of constraints. In this sense, continuous planning functions as a mechanism for maintaining flow reliability by ensuring that planned activities remain executable despite the constraints identified earlier in the project.

From a supply chain perspective, continuous planning addresses the inherent tension between loosely and tightly coupled systems in construction (Dubois & Gadde, 2002b). While upstream supply processes remain relatively independent, on-site production requires precise synchronization of deliveries, resources, and space. The empirical findings show that this synchronization is achieved through recurring planning practices, such as weekly logistics meetings, rolling schedules, and continuously updated APD plans. These mechanisms act as interfaces where actors align their activities and adjust plans based on updated information. This reflects the concept of joint planning, where collaboration across organizational boundaries is necessary to manage interdependencies in material flows (Sundquist et al., 2018). At the same time, the reliance on structured planning meetings and centralized logistics functions highlights that integration is not achieved solely through initial system design, but must be continuously reproduced through interaction between actors.

Digital tools further strengthen this coordination by increasing transparency and enabling proactive control of material flows. The use of delivery booking systems and shared planning platforms allows actors to visualize upcoming deliveries and identify capacity constraints in advance. This aligns with findings that digital delivery management systems support more stable logistics operations by reducing unplanned deliveries and improving coordination between actors (Fredriksson et al., 2024; Ekeskär & Rudberg, 2016). In the TBL project, this visibility can

enable logistics managers to detect delivery peaks weeks in advance and redistribute flows accordingly. However, this also illustrates a key dependency. The effectiveness of continuous planning relies on actors consistently updating and following the system. As a result, the benefits of digital planning tools depend not only on the technology itself, but also on the behaviour and commitment of project actors.

Despite these structured mechanisms, the findings also indicate that variability cannot be fully eliminated. Unexpected events, such as delays, weather conditions, or changes in production, require continuous adjustments to logistics plans. From a supply chain risk management perspective, continuous planning can therefore be understood as a mitigation mechanism that reduces the impact of disruptions rather than eliminating them (Jüttner et al., 2002). By maintaining updated plans, creating visibility of dependencies, and enabling rapid re-coordination, the system increases its resilience to disturbances. At the same time, the absence of on-site buffering capacity in the TBL project amplifies the consequences of deviations, meaning that the system becomes highly dependent on planning discipline and responsiveness. This highlights a fundamental trade-off. While structured and flow-oriented logistics reduce waste and inefficiencies, they also increase sensitivity to disruptions, requiring continuous adjustments to plans and activities in order to sustain performance.

5.3 Construction Logistics Plan as a governance tool

The findings indicate that the construction logistics plan (CLP), operationalized in the TBL project through the logistics appendix, functions as a central governance mechanism that translates logistics planning into enforceable practice. While pre-planning defines how logistics should be structured, the CLP establishes how this structure is maintained across actors throughout the project. In line with Lundesjö (2015) and Ying et al. (2018), the CLP provides a formalized framework that defines logistics processes, constraints, and responsibilities. However, the empirical findings show that its role extends beyond planning and communication, as it also acts as a contractual instrument that regulates behaviour and aligns incentives across the supply chain. By being included already in the procurement phase, the logistics appendix ensures that logistics requirements are not treated as optional guidelines, but as binding conditions that shape how subcontractors and suppliers organize their activities.

From a construction supply chain management perspective, the CLP can be understood as a mechanism for reducing fragmentation and enforcing integration across actors. Construction supply chains are typically characterized by siloed decision-making and myopic control, where individual actors optimize their own processes rather than overall project performance (Vrijhoef & Koskela, 2000; Morel et al., 2020). The logistics plan addresses this by standardizing logistics processes and defining shared rules for deliveries, material handling, and resource use. In doing so, it limits the degree of individual discretion and instead shifts control towards a centralized logic, where material flows are coordinated according to system-wide constraints. This reflects a

transition towards the fourth SCM role described by Vrijhoef and Koskela (2000), where the construction site is integrated into a broader supply chain perspective rather than managed as an isolated production unit. At the same time, the CLP supports the transfer of responsibilities from individual contractors to a centralized logistics function, often managed through a logistics manager or third-party provider, which aligns with findings on centralized logistics setups in construction (Thunberg & Fredriksson, 2023; Ekeskär & Rudberg, 2016).

In addition to enabling integration, the CLP also functions as a control mechanism that reduces uncertainty and mitigates risks in the logistics system. By specifying rules for delivery booking, time-slot management, access conditions, and material handling procedures, the document reduces variability in how logistics activities are performed. This aligns with the view of planning as a form of active control, where predefined structures are used to ensure that operations follow intended plans rather than being adjusted reactively (Ballard, 2000). From a supply chain risk management perspective, the CLP contributes to reducing both internal and network-related risks by clarifying interfaces between actors and minimizing the likelihood of process disruptions (Jüttner et al., 2002). In the TBL project, this is particularly important given the high interdependence between activities, where deviations in deliveries can quickly propagate across the system.

Furthermore, the contractual nature of the CLP influences economic behaviour within the project. By clearly defining logistics responsibilities and included services, such as centralized material handling, the respondents mean that it creates conditions for subcontractors to adjust their bids by excluding logistics-related activities. However, whether this effect is fully realized in practice remains uncertain. Previous research indicates that subcontractors do not always translate such structural changes into adjusted pricing, particularly when logistics costs are difficult to isolate or when there is limited trust in how the system will function during execution (Ekeskär & Rudberg, 2016; Fredriksson et al., 2025). This illustrates how governance mechanisms can shape not only coordination but also cost structures within the supply chain. At the same time, it highlights a critical dependency: the effectiveness of the CLP relies on its acceptance and enforcement across all actors. Without contractual backing, logistics requirements risk being treated as informal guidelines, leading to fragmented practices and reduced system performance. Overall, the findings suggest that the CLP is not merely a planning document. Instead it is a key governance tool that supports structured construction logistics by clarifying responsibilities, standardizing processes, and establishing common operating principles across the supply chain. It provides the formal foundation required to translate logistics strategies into consistent operational practices, thereby bridging the gap between planning and execution.

5.4 Construction logistics setup as an integrated system

The logistics setup in the TBL project can be understood as an integrated construction logistics system rather than a collection of separate solutions. Although the different modules are provided and operated by different actors, their value depends on how they are coordinated as a system. This aligns with the concept of construction logistics setups, where different logistics services are combined to control and follow up flows of material, waste, equipment, and information to, from, and within the construction site (Fredriksson et al., 2021). In the TBL project, the digital delivery system, terminal, checkpoint, logistics manager, and internal material distribution each address specific constraints, but their combined function is to create a controlled and predictable logistics flow in an environment with limited capacity and high sensitivity to disruptions.

This integrated setup can also be interpreted through a lean construction perspective, where the aim is to improve flow and reduce waste across the production system (Koskela et al., 2002). In particular, the combination of the terminal, checkpoint, and digital delivery system enables a form of JIT logistics, where materials are delivered in alignment with actual site readiness rather than stored on-site. The terminal functions as an external buffer that allows materials to be called off based on production needs, while the checkpoint and time-slot system regulate the final last mile delivery to ensure that materials arrive only when unloading capacity and space are available (Lundesjö, 2015; Janné & Fredriksson, 2021). In this sense, the logistics setup supports a shift from traditional push-based delivery patterns towards a more controlled and partially pull-oriented system (Kalsaas et al., 2015; Seppänen & Peltokorpi, 2016). However, this pull logic is not uniformly applied across the system. While upstream deliveries from suppliers often remain planned and push-oriented due to long lead times and supply constraints, the 3PL-operated flows enable a more demand-driven approach. Materials stored in the terminal or long-term storage can be released based on actual production needs. While the final delivery stage, from checkpoint to site, functions as a tightly controlled last mile JIT flow in the project.

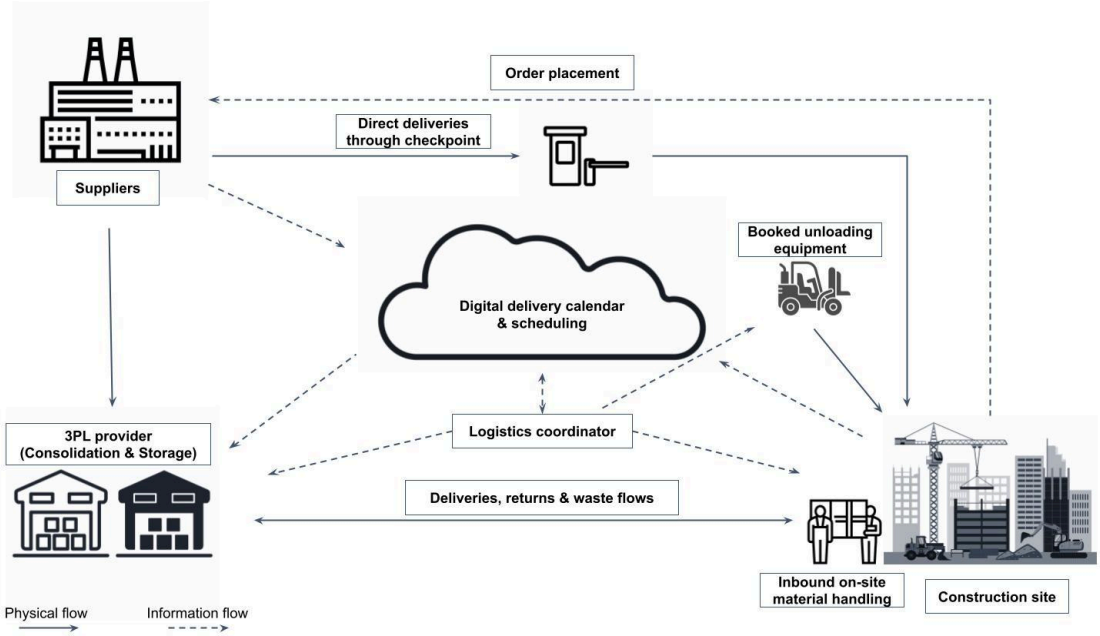

Figure 6.3: Integrated construction logistics setup illustrating physical and information flows within the project

As illustrated in Figure 6.3, the logistics setup relies on tightly interconnected physical and information flows, where deliveries, resource bookings, and on-site handling are coordinated through the digital system and mediated by the logistics manager. This also implies that disruptions in one part of the system, such as unbooked unloading equipment or inaccurate delivery information, can propagate across the system and directly affect on-site operations.
A central analytical point is that the different parts of the setup manage distinct interfaces in the logistics system. The terminal and long-term storage facilities manage the interface between suppliers and the project by shifting storage, consolidation, and flow control away from the constrained site. The checkpoint manages the interface between external transport flows and the hospital area by ensuring that vehicles are only released when the site can receive them. The digital system manages the information interface by making planned deliveries, resource needs, and capacity limitations visible to the actors involved. The logistics manager then acts as the operational interface between these components, translating digital information and planning decisions into practical coordination on site. In this way, the setup reduces the gap between off-site supply activities and on-site production, which is a key challenge in construction supply chains (Dubois & Gadde, 2002b; Naz & Fredriksson, 2023).

However, the effectiveness of this integration depends on the alignment between these interfaces. The digital delivery system enables transparency, but it does not coordinate by itself unless actors actively update and follow the system. The terminal can reduce transport pressure, but only if deliveries are booked, consolidated, and released according to site capacity. Similarly, the checkpoint can prevent queuing and protect critical infrastructure, but only if it is continuously

aligned with real-time site conditions and delivery schedules. For example, if unloading equipment is not pre-booked in alignment with the delivery schedule, vehicles may arrive without available handling capacity, leading to delays, congestion, or rejected deliveries. This illustrates how coordination failures are not isolated events, but can affect multiple interdependent activities within the system. This is consistent with Lundesjö (2015), who emphasizes that consolidation centres and external logistics solutions function primarily as control mechanisms that reduce congestion and improve planning conditions in constrained environments. At the same time, Lundesjö highlights that such solutions must be selectively applied, as certain material flows are more efficiently handled through direct deliveries. This trade-off is also visible in the TBL project, where a combination of consolidated and direct flows is required to balance efficiency and flexibility.

The interdependencies between components can be further understood through the ARA-model (Actors, Resources, Activities) (Sundquist et al., 2018). The logistics setup reorganizes activities, such as material handling and delivery coordination, by shifting them from individual contractors to centralized functions. At the same time, resources, such as unloading equipment, terminal capacity, and digital systems, become shared and must be jointly managed. This creates new dependencies between actors, where subcontractors, logistics providers, and the general contractor are increasingly reliant on each other's actions. As a result, coordination is not only a matter of planning, but of continuously aligning activities, resources, and actors within a tightly coupled system. From this perspective, the logistics setup can be understood as a modular system, where individual services are designed separately but must function collectively to deliver the most value. While modularization simplifies the design and implementation of logistics services, it also increases the need for alignment between actors, as each module introduces new dependencies (Fredriksson et al., 2025). The effectiveness of the system is therefore not determined by the performance of individual components, but by the alignment between them. This creates a governance challenge, particularly in a project environment characterized by multiple independent actors and temporary organizational structures. From a supply chain management perspective, the setup represents a movement towards more integrated management of the construction site and the wider supply chain. However, the TBL case also illustrates the difficulty of achieving full integration in practice. Since the setup is distributed across multiple organizations, coordination depends on shared information, clear responsibilities, and compliance with common procedures. This creates a structural vulnerability, where the performance of the system depends on consistent behaviour across all actors.

5.5 Performance implications and trade-offs

The findings indicate that the performance implications of the logistics setup in the TBL project are primarily linked to increased control, reduced variability, and improved coordination of material flows. However, an important analytical insight is that the implementation of the logistics system is not primarily driven by efficiency gains alone, but rather by the need to

manage risk in a highly constrained and sensitive project environment. In this sense, the logistics setup functions as a risk mitigation mechanism, where the primary objective is to ensure predictability and avoid disruptions to both construction activities and surrounding hospital operations. This reflects findings in the literature that construction logistics solutions are often implemented to address external pressures, such as reducing disturbances and ensuring operational continuity, rather than purely to optimize internal efficiency (Janné & Fredriksson, 2021; Ekeskär & Rudberg, 2016).

At the same time, the empirical findings suggest that once such a structured system is in place, it creates conditions for improved performance across several dimensions. From a lean construction perspective, the logistics setup contributes to improved flow by reducing non-value-adding activities such as waiting, searching for materials, and unnecessary handling (Koskela, 2000). This is particularly evident in the observations highlighted by Respondent G, who emphasized that productivity losses in construction are often not caused by major disruptions, but by the accumulation of many small inefficiencies, such as waiting for elevators, relocating materials, or resolving conflicts over shared resources. By introducing structured delivery planning, coordinated material handling, and clear allocation of resources, the logistics system targets precisely these dispersed inefficiencies. This supports the idea that logistics solutions create value not through isolated improvements, but by systematically reducing variability and friction in the production system.

In addition to operational efficiency, the findings also point to broader value creation in line with the multidimensional perspective of construction logistics setups. The system generates technical value through improved functionality and control of material flows, for example through digital delivery management and resource allocation. It creates monetary value by enabling reduced transport volumes, lower handling costs, and potentially lower subcontractor bids, as logistics activities are centralized and removed from individual actors. Furthermore, perceptual value is created through increased transparency, improved working conditions, and greater predictability for both contractors and the client (Fredriksson et al., 2025). However, it is important to note that these value dimensions are not equally distributed across actors. While the client and general contractor benefit from improved control and reduced risk, subcontractors may initially perceive the system as an additional constraint, particularly due to stricter planning requirements and reduced flexibility (Sundquist et al., 2018).

This highlights several important trade-offs associated with the logistics setup. One key trade-off relates to the balance between flexibility and control. In traditional construction projects, spatial buffers and informal coordination allow actors to handle disruptions reactively. In contrast, the TBL setup reduces these on-site buffers and replaces them with structured planning and controlled delivery processes, increasing the need for discipline and forward planning. While this improves flow stability and predictability, it also shifts flexibility away from the construction site

towards external logistics resources such as terminals, buffer storage, and coordinated transport management. Consequently, the effectiveness of the system becomes increasingly dependent on the ability to combine structured planning with sufficient adaptability to manage unforeseen changes and disruptions during production (Seppänen & Peltokorpi, 2016; Vrijhoef & Koskela, 2000). Another trade-off concerns the visibility of costs and benefits. The logistics system introduces explicit costs, for example for terminal operations, logistics manager, and digital systems, which are clearly visible in the project budget. At the same time, many of the benefits, such as reduced waiting times, improved productivity, and avoided disruptions, remain difficult to quantify. This creates a potential mismatch between perceived and actual value, particularly for actors who do not directly experience the system-wide benefits (Thunberg & Fredriksson, 2023). Finally, the setup introduces a trade-off between specialization and complexity. While the use of dedicated logistics actors can improve efficiency and allows production actors to focus on core tasks, it also increases the number of interfaces that must be managed. The system therefore becomes highly dependent on information sharing, compliance with procedures, and effective coordination across organizational boundaries (Persson et al., 2010). Overall, the findings suggest that the logistics setup in the TBL project creates significant potential for improved performance, particularly in terms of flow efficiency, resource utilization, and risk reduction. However, these benefits are closely tied to the ability to manage the inherent trade-offs related to cost visibility, reduced flexibility, and increased cooperation requirements. This reinforces the view that construction logistics setups should not be evaluated solely based on isolated efficiency gains, but rather as system-level interventions that reshape how value is created and distributed across the construction supply chain.

6. Conclusions

The following chapter will bring the thesis project to a close with the research questions addressed firstly, followed by a final recommendation to the project actors. The chapter concludes with a section presenting the contribution to research and final suggestions regarding potential future research projects.

6.1 Planning and implementation of construction logistics

This study demonstrates that planning and implementation of construction logistics extend beyond traditional scheduling activities and instead function as a central mechanism for controlling and coordinating material flows in complex project environments. In the TBL project, logistics planning is not confined to a single phase but evolves across the project lifecycle, beginning in early project stages and continuing throughout production. This progression reflects a shift from reactive problem-solving towards a proactive and structured approach, where logistics is actively used to shape the conditions under which construction activities are executed. A key finding is that early integration of logistics considerations is critical for effective implementation. By introducing logistics already during procurement, the project establishes a foundation where constraints, responsibilities, and system requirements are defined before production begins. This enables logistics to be embedded within both contractual and organizational structures, rather than treated as a supporting function introduced later. In line with previous research, early planning allows for the identification of constraints and alignment of material flows with project conditions, reducing the risk of disruptions during execution. In the TBL project, this early integration is particularly important due to the constrained hospital environment, where limited flexibility requires that logistics solutions are defined in advance rather than adjusted during production.

The findings further highlight the importance of structured pre-planning, where logistics analysis functions as a mechanism for connecting supply chain activities with on-site production. Rather than focusing solely on site efficiency, planning activities extend across the supply chain, supporting coordination of material flows, resource allocation, and site layout decisions. This reflects a more integrated supply chain perspective, where the construction site is treated as part of a broader system rather than an isolated production unit. The identified hygiene factors can be understood as essential enablers for reducing fragmentation and overcoming silo-based decision-making. By establishing clear responsibilities and shared planning processes, these elements contribute to improved information flow and alignment between actors, which are critical for managing the interdependencies inherent in construction projects. In addition, the study shows that planning must be continuously refined during production in order to remain effective. The use of rolling schedules, weekly meetings, and digital delivery management systems enables the project to adapt logistics flows to actual production conditions. This aligns

with the principles of the Last Planner System, where planning evolves from long-term intentions to short-term commitments through ongoing constraint management and coordination. In the TBL project, continuous planning serves not only to adjust to changes but also to maintain control over a system with limited capacity and high sensitivity to disruptions. As such, planning becomes an active process of ensuring that conditions remain aligned with the plan, rather than merely responding to deviations.

6.2 Managing constraints through structured logistics systems

The findings of this study show that constraints in construction logistics are not merely limitations to be mitigated, but fundamental conditions that shape how logistics systems must be designed and managed. In the TBL project, constraints related to space, access, and the surrounding hospital environment significantly reduce operational flexibility and eliminate the possibility of relying on ad hoc logistics practices. Instead of absorbing variability through on-site storage or reactive adjustments, the project is required to actively manage and control flows to maintain stable operations. This reflects a shift in how constraints are approached, from being treated as operational obstacles to acting as key drivers for the development of structured logistics systems.

A central insight is that constraints in the TBL project are highly interdependent, originating from both external and internal conditions. Limited space restricts storage capacity, which in turn increases reliance on precise delivery timing, while access limitations further constrain the ability to adjust flows once disruptions occur. This interconnected structure creates a tightly coupled system, where even minor deviations in deliveries or resource availability can lead to cascading effects across multiple activities. Such dynamics are consistent with previous research on construction supply chains, where strong interdependencies and limited integration contribute to high vulnerability to disruptions. In this context, managing constraints is not about addressing isolated issues, but about understanding and controlling their combined impact on the system as a whole.

The study further demonstrates that structured logistics systems play a critical role in enabling this form of constraint management. By introducing solutions such as delivery management systems, consolidation centres, checkpoints, and dedicated logistics roles, the project establishes mechanisms for controlling both physical flows and organizational processes. These systems function as tools for reducing variability, regulating access, and aligning material flows with production needs. Rather than relying primarily on on-site flexibility, the logistics setup replaces it with planning, coordination, and control, thereby increasing predictability in a constrained environment. This approach reflects principles associated with lean construction and supply chain integration, where the focus shifts from managing uncertainty through redundancy to minimizing variability through structured processes. At the same time, the findings highlight that managing constraints through structured systems introduces new dependencies and requirements.

As possibilities for ad hoc adjustments are reduced, the system becomes increasingly reliant on accurate planning, disciplined execution, and consistent adherence to established procedures. This creates a trade-off where the ability to absorb disturbances is replaced by the need to prevent them. Consequently, constraint management is not only a technical challenge but also an organizational one, requiring alignment between actors and a shared commitment to coordinated processes.

6.3 Integrated logistics setups as coordination mechanisms

This study shows that individual construction logistics solutions can address specific operational challenges. However, greater value is achieved when material flows, resources, and actors are managed within a coherent logistics system. In the TBL project, the logistics setup consists of multiple interrelated components. While each of these solutions addresses specific challenges, their primary contribution lies in how they function together as an integrated system for managing complexity and interdependencies in the project environment. A central finding is that integration is achieved through the alignment of both physical and informational flows. The digital delivery management system plays a key role in enabling this by providing a shared platform for planning, monitoring, and coordinating deliveries and resource usage. By making information visible across the supply chain, the system supports synchronization between upstream activities and on-site operations, allowing actors to adjust their actions based on common data. This reduces fragmentation, which is particularly important in construction projects where supply chains are traditionally characterized by siloed decision-making and limited information sharing. In the TBL project, this visibility enables a more proactive approach, where potential disruptions can be identified and managed before they affect production.

In addition to digital integration, the findings highlight the importance of physical logistics solutions in structuring material flows. The use of a consolidation terminal reduces the number of deliveries to the site and enables better control over inbound logistics, while the checkpoint regulates access and ensures that deliveries are aligned with available capacity on-site. These solutions contribute to stabilizing the flow of materials and reducing congestion in a highly constrained environment. However, their effectiveness depends on their integration with planning processes and digital systems, illustrating that physical and digital elements must be tightly coupled to achieve overall system performance. The study also emphasizes the role of centralized logistics functions in supporting coordination between project actors. The logistics manager functions as a central actor responsible for managing interactions between different stakeholders, ensuring adherence to established processes, and maintaining alignment between planning and execution. This reflects a shift in responsibility from individual subcontractors to a centralized function, which is consistent with the concept of construction logistics setups as a form of supply chain reorganization. By centralizing control over logistics activities, the system reduces the reliance on individual actors' decision making and instead promotes a more

coordinated and system-oriented approach. At the same time, the findings indicate that logistics setups introduce new coordination challenges. As logistics activities are distributed across multiple actors and service providers, the system becomes dependent on effective communication, shared understanding, and consistent use of tools and processes. The modular nature of logistics solutions increases the need to align different logistics functions and actors, as misalignment in one part of the system can affect overall performance. This highlights a key trade-off, where increased specialization and centralization improve efficiency but also require stronger mechanisms for integration and governance.

6.4 Future research

One key area concerns the measurement of performance and efficiency of logistics solutions. While respondents described clear benefits related to reduced transport volumes, improved coordination, and increased productivity, these effects were largely based on experience rather than systematically measured data. Future research could therefore focus on developing methods to quantify time savings, resource utilization, and productivity improvements across different project phases. Such measurement frameworks would enable more objective comparisons between projects and provide stronger support for investment decisions in logistics solutions.

A second area relates to the economic implications of logistics strategies, particularly regarding off-site solutions such as consolidation terminals and long-term storage. Although respondents emphasized potential cost advantages, for example through bulk purchasing and reduced on-site handling, these effects were not explicitly quantified in the TBL project. Further research could investigate the structure of such construction logistics setups, including both direct costs and avoided costs, in order to better understand the financial trade-offs associated with different logistics setups.

In addition, the findings point to the importance of organizational and behavioral factors in the successful implementation of logistics solutions. Several respondents highlighted challenges related to user adoption, resistance to new systems, and the need for discipline in following planned processes. Future studies could therefore explore how different actors within construction projects, such as subcontractors and site personnel, perceive and adapt to structured logistics systems, and how these factors influence overall project performance.

Finally, the increasing use of digital tools suggests a need for further research into data integration and information flows in construction logistics. Respondents described the potential of connecting logistics systems with digital design tools and supply chain data, but also noted challenges related to standardization and data quality. Future research could examine how digital integration can be developed to support more automated and proactive logistics planning across the entire project lifecycle. Future research could also explore how newer technologies, such as

BIM-to-BOM integration, can support supply chain management and logistics planning in construction projects.

References

Andayesh, M., & Sadeghpour, F. (2015). The constructs of site layout modeling: an overview. *Canadian Journal of Civil Engineering*, 42(3), 199-212. https://doi.org/10.1139/cjce-2014-0303

Baghalzadeh Shishehgarkhaneh, M., Moehler, R. C., Fang, Y., Aboutorab, H., & Hijazi, A. A. (2024). Construction supply chain risk management. *Automation in Construction*, 162, 105396. https://doi.org/10.1016/j.autcon.2024.105396

Ballard, G. (2000). *The last planner system of production control* (Doctoral dissertation, University of Birmingham). https://etheses.bham.ac.uk/4789/

Beard, J. L., Duncan, D. W., Loulakis, M. C., & Wundram, E. C. (2001). *Design-build: Planning through development*. McGraw-Hill Professional Publishing.

Briscoe, G. H., Dainty, A. R. J., Millett, S. J., & Neale, R. H. (2004). Client-led strategies for construction supply chain improvement. *Construction Management and Economics*, 22(2), 193-201. https://doi.org/10.1080/0144619042000201394

Brown, A. (2013). Defining the role of the construction logistics manager. *Construction Research and Innovation*, 4(4), 28–29. https://doi.org/10.1080/20450249.2013.11873910

Brusselaers, N., Fredriksson, A., Gundlegård, D., & Zernis, R. (2024). Decision support for improved construction traffic management and planning. *Sustainable Cities and Society*. https://doi.org/10.1016/j.scs.2024.105305

Byggföretagen Analys. (2025). *Byggkonjunkturen #2 2025: Konjunkturrapport oktober 2025*. Byggföretagen. https://byggforetagen.se/app/uploads/2025/10/Byggkonjunkturen2_2025.pdf

Cheng, E. W. L., Li, H., Love, P., & Irani, Z. (2004). A learning culture for strategic partnering in construction. *Construction Innovation*, 4(1), 53-65. https://doi.org/10.1108/14714170410815006

Crane, T. G., Sanders, S. R., Felder, J. P., Thompson, M. G., & Thompson, P. J. (1997). Partnering Process Model. *Journal of Management in Engineering*, 13(3), 57-63. https://doi.org/10.1061/(ASCE)0742-597X(1997)13:3(57)

Daniel, E. I., Pasquire, C., Dickens, G., & Ballard, H. G. (2017). The relationship between the Last Planner® System and collaborative planning practice in UK construction. *Engineering,*

Construction and Architectural Management, 24(3), 407–425. https://doi.org/10.1108/ECAM-07-2015-0109

Dawood, N., & Mallasi, Z. (2004). Workspace competition: Assignment and quantification utilising 4D visualisation tools. In *Proceedings of the Conference on Construction Applications of Virtual Reality*.

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

Dubois, A., & Gadde, L.-E. (2002b). The construction industry as a loosely coupled system: implications for productivity and innovation. *Construction Management and Economics*, 20(7), 621-631. https://doi.org/10.1080/01446190210163543

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

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

Fellows, R. F., & Liu, A. M. M. (2008). *Research methods for construction* (3rd ed.). Wiley-Blackwell.

Fernández-Solís, J. L. (2008). The systemic nature of the construction industry. *Architectural Engineering and Design Management*, 4(1), 31-46. https://doi.org/10.3763/aedm.2008.S807

Forbes, L. H., Ahmed, S. M., & Taylor, F. (2011). *Modern construction: Lean project delivery and integrated practices* (1st ed.). CRC Press. https://doi.org/10.1201/b10260

Fredriksson, A., Ivert, L. K., & Naz, F. (2025). Creating logistics service value in construction – a quest of coordinating modules in a loosely coupled system. *Construction Management and Economics*, 43:6, 428-445. https://doi.org/10.1080/01446193.2025.2449996

Fredriksson, A., Sezer, A. A., & Sundquist, V. (2024). *C*onstruction logistics status and actors' opinions – an industry wide survey in Sweden. *Construction Innovation*. https://doi.org/10.1108/CI-10-2023-0255

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

Granja, A. D., & Picchi, F. A. (2004). Construction Sites: Using LEAN Principles to Seek Broader Implementations. *Paper presented at the 12th Annual Conference of the International Group for Lean Construction*, Helsingør, Denmark.

Hammad, A., Zhang, C., Al-Hussein, M., & Cardinal, G. (2007). Equipment workspace analysis in infrastructure projects. *Canadian Journal of Civil Engineering*, 34(10), 1247-1256. https://doi.org/10.1139/l07-048

Handa, V., & Lang, B. (1989). Construction site efficiency. *Construction Canada*, 89, 40-48.

Hayes-Roth, B., Levitt, R. E., & Tommelein, I. D. (1992a). SightPlan Model for Site Layout. *Journal of Construction Engineering and Management*, 118(4), 749-766. https://doi.org/10.1061/(ASCE)0733-9364(1992)118:4(749)

Hayes-Roth, B., Levitt, R. E., & Tommelein, I. D. (1992b). Site-Layout Modeling: How Can Artificial Intelligence Help? *Journal of Construction Engineering and Management*, 118(3), 594-611. https://doi.org/10.1061/(ASCE)0733-9364(1992)118:3(594)

Hamzeh, F., Tommelein, I., Ballard, G., & Kaminsky, P. M. (2007). Logistics centers to support project-based production in the construction industry. In *Proceedings of the 15th Annual Conference of the International Group for Lean Construction (IGLC 15)*. https://doi.org/10.13140/RG.2.1.4328.6563

Josephson, P.-E., & Saukkoriipi, L. (2005). *Slöseri i byggprojekt: Behov av förändrat synsätt*. https://www.cmb-chalmers.se/wp-content/uploads/2015/10/sloseri_byggprojekt.pdf

Jüttner, U., Peck, H., & Christopher, M. (2002), *S*upply chain risk management: outlining an agenda for future research, in Griffiths, J., Hewitt, F. and Ireland, P. (Eds), *Proceedings of the Logistics Research Network 7th Annual Conference*, pp. 443‐50. https://doi.org/10.1080/13675560310001627016

Kadefors, A., Chalmers University of, T., School of Technology, M., Economics, Chalmers

tekniska, h., Institutionen för service, m., & Department of Service, M. (2004). *Trust in project relationships—inside the black box*. International Journal of Project Management, 22(3), 175-182. https://doi.org/10.1016/S0263-7863(03)00031-0

Kalsaas, B. T., Skaar, J., & Thorstensen, R. T. (2015). Pull vs. push in construction work informed by Last Planner. *Proceedings of the 23rd Annual Conference of the International Group for Lean Construction* (pp. 103–112). International Group for Lean Construction.

Koskela, L., Howell, G., Ballard, G., & Tommelein, I. (2002). The foundations of lean construction. In R. Best & G. de Valence (Eds.), *Design and construction: Building in value* (pp. 211–226). Butterworth-Heinemann. https://doi.org/10.4324/9780080491080-16

Lange, S., & Schilling, D. (2015). Reasons for an optimized construction logistics. In *Proceedings of the 23rd Annual Conference of the International Group for Lean Construction* (pp. 733–742).

Liker, J. K. (2004). *The Toyota way: 14 management principles from the world's greatest manufacturer*. New York: McGraw-Hill.

Lu, W. X., Hua, Y. Y., & Zhang, S. J. (2017). Logistic regression analysis for factors influencing cost performance of design-bid-build and design-build projects. Engineering, *Construction and Architectural Management*, 24(1), 118-132. https://doi.org/10.1108/ECAM-07-2015-0119

Ljungberg, C., Sundberg, R., & Wendle, B. (2012). *Trender med påverkan på samhällsplaneringen: Omvärldsanalys med fokus på transport, infrastruktur och bebyggelse*. https://www.trivectortraffic.se/wp-content/uploads/2019/09/trender_med_paverkan_pa_samhallsplaneringen__2012_69_skickad.pdf

Lundesjö, G. (Ed.). (2015). *Supply chain management and logistics in construction: Delivering tomorrow's built environment*. Kogan Page. ISBN 9780749472429.

Ma, Z., Shen, Q., & Zhang, J. (2005). Application of 4D for dynamic site layout and management of construction projects. *Automation in Construction*, 14(3), 369-381. https://doi.org/10.1016/j.autcon.2004.08.011

Masterman, J. W. E. (2001). *Introduction to building procurement systems* (2nd ed.). Spon Press.

McKinsey Global Institute. (2017). *Reinventing construction: A route to higher productivity*. https://www.mckinsey.com/~/media/mckinsey/business%20functions/operations/our%20insights

/reinventing%20construction%20through%20a%20productivity%20revolution/mgi-reinventing-construction-a-route-to-higher-productivity-full-report.pdf/

Mohsini, R. A., & Davidson, C. H. (1992). Determinants of performance in the traditional building process. *Construction Management and Economics*, 10(4), 343-359. https://doi.org/10.1080/01446199200000030

Naz, F., & Fredriksson, A. (2023). Clarifying the interface between construction supply chain and site. *IFIP Advances in Information and Communication Technology*, 691. https://doi.org/10.1007/978-3-031-43693-9_17

Norrman, A. (2025). *Supply chain risk management och resilience hos svenska företag* (LUTMDN/TMTP-3130-SE). Lunds tekniska högskola.

Norrman, A., & Jansson, U. (2004). Ericsson's proactive supply chain risk management approach after a serious sub-supplier accident. *International Journal of Physical Distribution & Logistics Management, 34*(5), 434–456. https://doi.org/10.1108/09600030410545463

Nyström, J. (2005). The definition of partnering as a Wittgenstein family-resemblance concept. *Construction Management and Economics*, 23(5), 473-481. https://doi.org/10.1080/01446190500040026

Paez, O., Salem, S., Solomon, J., & Genaidy, A. (2005). Moving from lean manufacturing to lean construction: Toward a common sociotechnological framework. *Human Factors and Ergonomics in Manufacturing*, 15(2), 233–245. https://doi.org/10.1002/hfm.20023

Peab. (2026, March 13). Peab bygger till sjukhusbyggnader i Lund. https://peab.se/om-peab/bolagsinformation/press-och-media/pressmeddelanden/2026/mars/peab-bygger-till-sjukhusbyggnader-i-lund/

Peiris, P.A.N., Hui, F.K.P., Ngo, T., Duffield, C., & Garcia, M.G. (2023). Challenges in transport logistics for modular construction: A case study. *12th International Conference on Structural Engineering and Construction Management*. Springer, Singapore. https://doi.org/10.1007/978-981-19-2886-4_35

Persson, F., Bengtsson, J., & Gustad, Ö. (2010). Construction logistics improvements using the SCOR model – Tornet case. In *Advances in Production Management Systems: New Challenges, New Approaches*. Springer. https://doi.org/10.1007/978-3-642-16358-6_27

Russell, A., Staub-French, S., Tran, N., & Wong, W. (2009). Visualizing high-rise building

construction strategies using linear scheduling and 4D CAD. *Automation in Construction*, 18(2), 219-236. https://doi.org/10.1016/j.autcon.2008.08.001

Sacks, R. (2013). *Modern Construction: Lean Project Delivery and Integrated Practices. Construction Management and Economics*, 31(4), 394-396. https://doi.org/10.1080/01446193.2013.763999

Seppänen, O., & Peltokorpi, A. (2016). A new model for construction material logistics: From local optimization of logistics towards global optimization of on-site production system. In *Proceedings of the 24th Annual Conference of the International Group for Lean Construction* (pp. 73–82).

Sullivan, G., Barthorpe, S., & Robbins, S. (2010). *Managing construction logistics*. Wiley-Blackwell. https://doi.org/10.5130/ajceb.v10i4.1885

Stadtler, H. (2000). Supply chain management—An overview. In H. Stadtler & C. Kilger (Eds.), *Supply chain management and advanced planning*. Springer. https://doi.org/10.1007/978-3-662-04215-1_2

Thompson, P. J., & Sanders, S. R. (1998). Partnering continuum. *Journal of Management in Engineering*, 14(5), 73-78. https://doi.org/10.1061/(ASCE)0742-597X(1998)14:5(73)

Thunberg, M., & Fredriksson, A. (2023). *A model for visualizing cost shifts when introducing construction logistics setups*. Construction Innovation: Information, Process, Management, 23(4), 757–774. https://doi.org/10.1108/CI-10-2020-0168

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

Walker, D. H. T., & Lloyd-Walker, B. M. (2015). *Collaborative project procurement arrangements*. Project Management Institute.

Wegelius-Lehtonen, T. (2001). *Performance measurement in construction logistics*. International Journal of Production Economics, 69(1), 107–116. https://doi.org/10.1016/S0925-5273(00)00034-7

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). Sage.

Ying, F., Tookey, J., & Seadon, J. (2018). *Measuring the invisible: A key performance indicator for managing construction logistics performance*. Benchmarking: An International Journal, 25(6), 1921–1934. https://doi.org/10.1108/BIJ-11-2016-0176

Appendix A - Interview Guide (General construction logistics)

Background information

- Can you describe your role and experience within construction logistics?
- What types of projects do you typically work with?

Construction logistics in general

- How would you describe the current state of construction logistics?
- What are the main challenges in construction logistics today?
- What distinguishes construction logistics from logistics in other industries?

Planning and early-stage decisions

- How should construction logistics be planned in early project stages?
- Which aspects of logistics planning are most critical?
- What role does a Construction Logistics Plan (CLP) play in practice?

Logistics solutions

- What is your view on solutions such as 3PL, consolidation centres, checkpoints, and digital systems?
- Which solutions create the most value in practice?
- Is it individual solutions or the combination of solutions that matters most?

Coordination and integration

- How does coordination between actors affect logistics performance?
- What challenges exist in achieving integration across the supply chain?
- How does “silo mentality” (Fragmentation) impact logistics?

Risks and disruptions

- Where do logistical disruptions typically occur?
- What are the main risks associated with construction logistics?
- How can these risks be mitigated?

Reflection

- What differentiates projects where logistics works well from those where it does not?
- Why is it difficult to implement improved logistics solutions?

Appendix B -Interview Guide (Project-specific)

Background and role

- Can you describe your role in the project?
- What responsibilities do you have related to logistics?
- To what extent have you been involved in logistics planning?

Logistics planning

- How was logistics planned in the early stages of the project?
- What were the most important factors to consider?
- How did the hospital environment influence planning?
- How were decisions regarding logistics solutions made (e.g., 3PL, digital systems)?
- How were roles and responsibilities defined?
- To what extent has actual execution matched the initial planning?

Logistics solutions and execution

- What are the main logistical challenges on-site?
- What typically causes disruptions in production related to logistics?
- How do factors such as space constraints, delivery volumes, and time pressure affect operations?
- How do the implemented logistics solutions contribute to the project?
- Have similar solutions been used in previous projects?

Coordination and actors

- How are different actors coordinated within the logistics system?
- How does collaboration with logistics partners function?
- How is responsibility distributed when issues occur?
- How is information shared between actors?

Risks and challenges

- What were the main logistical risks during the planning phase?
- How were these risks managed?

Performance and outcomes

- How does logistics affect project efficiency?
- Have the implemented solutions reduced disruptions or waiting times?

Reflection

- What has worked well in the logistics setup?
- What would you do differently in a similar project?

- How should construction logistics develop in the future?