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Efficiency as a Shield: The Contribution of Construction Logistics to Enhancing Safety

A Case Study of Construction Logistics Management and Safety & Health at Skanska

Master's Thesis in Master Program Design and Construction Project Management

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Cover: The Gate to Lilla Backa project (own picture).

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Abstract

The construction industry is one of the most accident-prone sectors, with a concerning upward trend in fatal incidents. This alarming situation necessitates a concentrated effort to understand the underlying causes. This report investigates the complex relationship between construction logistics and occupational health and safety on construction sites, with a particular focus on identifying and analyzing the key determinants that drive construction workers to take risks and bypass safety measures. The research aims to demonstrate how effective logistical planning and management can significantly enhance safety outcomes in construction projects, thereby increasing understanding of where accidents occur and why risks are taken, and further motivating the use of construction logistics as a safety-enhancing factor.

The study, centered on Skanska's practices, reveals that the effective implementation of logistics tools, such as Construction Consolidation Centers (CCCs) and third-party logistics (TPL) providers, correlates strongly with improved occupational health and safety on construction sites. These tools streamline operations and reduce the risk of accidents. Additionally, the research identifies key logistical elements that impact safety, including delivery scheduling, material handling, and storage solutions, emphasizing that their optimization contributes to a safer working environment. The findings indicate that high-pressure environments, tight deadlines, and inadequate training are primary determinants driving risky behaviors among construction workers. Enhancing communication, providing continuous safety training, and fostering a culture of safety are critical in mitigating these risks. Furthermore, the study highlights the necessity for adaptive logistics strategies in complex projects to maintain safety standards and ensure efficient project execution. Overall, this research highlights the crucial role of construction logistics in enhancing safety and provides practical recommendations for industry stakeholders to adopt and implement more effective and safer logistical practices.

Keywords: Construction Logistics, Construction Safety, Health and Safety, Construction Industry Accidents, On-site Logistics.

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Finally, we would like to acknowledge the support of our friends, whose encouragement and help have been unwavering throughout our studies and the completion of this thesis.

Arvid Edlund & Saga Björk Kotte, Gothenburg, June 2024

Contents

List of Acronyms

Below is the list of acronyms that have been used throughout this thesis listed in alphabetical order:

AFS	Arbetsmiljöverkets FörfattarSamling (The Swedish Work Environment Authority's Collection of Regulations)
AML	ArbetsMiljöLagen (The Work Environment Act)
CCC	Construction Consolidation Centre
JIT	Just In Time
OSH	Occupational Safety and Health
PPE	Personal Protective Equipment
RFID	Radio Frequency IDentification
SBUF	Svenska Byggbranschens UtvecklingsFond
S-CAT	Safety Climate Assessment Tool
TPL	Third Party Logistics
Vsaa	Vårt sätt att arbeta (Our way of working)

List of Figures

List of Tables

1
Introduction

The following Introduction provides the background of the report, followed by its aim, research questions, and limitations. It sets the context for the study, defining the primary objectives and key questions that guide the research.

1.1 Background

The construction industry is, according to Arbetsmiljöverket (2023b), one of the sectors with the highest number of serious accidents. It is characterized by temporary and mobile workplaces that constantly introduce new occupational risks. Berglund et al. (2023) explains that the complex nature of construction projects, which involve multiple stakeholders and dynamic conditions, underscores the need for effective planning and collaboration to create a safe working environment. Numbers from Arbetsmiljöverket (2024) show that in 2023, the construction industry reported a significant increase in workplace accidents, with a 37.5 percent rise in fatal accidents compared to the previous year, marking the highest number since 2010. This alarming trend highlights the ongoing challenges in maintaining a safe work environment and the urgent need to review and improve safety measures. Despite the critical importance of safety, there is, according to Berglund et al. (2023) a notable gap in Swedish research focused on the construction industry's risks and safety practices. Specifically, there is a lack of sociological perspectives on accidents and insufficient applied research on integrated systems involving subcontractors. Bridging this gap is essential to enhance safety and occupational health more effectively.

Furthermore, according to Taljegård (2022) on-site logisticsactivities such as loading and unloading account for a significant portion of accidents on construction sites. A review of existing literature reveals that logisticstools and improved logistics are frequently cited as measures that enhance onsite safety. However, the precise extent of this improvement is rarely quantified, indicating a significant gap in both research and practical application. This gap needs to be addressed to better understand and leverage the potential safety benefits of logisticstools in the construction industry. The construction industry is known for its highly competitive nature, where financial considerations often take precedence. Investments in construction logistics are typically concealed within overall project costs, leading to the perception of logistics as an expense rather than an economic benefit. This perspective makes it challenging to justify the adoption of logisticstools, as they are often seen as a cost without immediate visible returns. Moreover, the lack of specific measurements on how lo-

gisticstools impact onsite safety further complicates their justification. There is a need for more detailed research that quantifies the safety benefits of logisticstools. Such data would provide a clearer understanding of their value, potentially transforming the perception of logistics from a mere cost factor to a critical component of safety and efficiency in construction projects. Improved logistics can lead to fewer accidents, enhancing overall project safety. By demonstrating the concrete safety benefits, it becomes possible to argue for the inclusion of logisticstools in project planning and budgeting. This would not only improve safety but could also lead to economic benefits by reducing accident-related costs and improving overall project efficiency. Addressing this research gap is essential for advancing the practical application of logisticstools in the construction industry. More specific measurements and studies are needed to provide concrete evidence of the extent to which logisticstools can enhance onsite safety. Such evidence would be crucial in motivating the adoption of these tools, ultimately contributing to safer and more efficient construction sites.

1.2 Aim

The aim of this thesis is to uncover how effective logistical planning and management can enhance safety outcomes in construction projects. By examining the practices and safety culture at Skanska, the study seeks to understand the current challenges and opportunities within construction logistics that impact worker safety. Furthermore, the purpose of this thesis is to investigate the intricate relationship between construction logistics and occupational health and safety on construction sites, with a focus on identifying and analyzing the key determinants that drive construction workers to take risks and bypass safety measures.

Additionally, the thesis aims to delve into the individual and cultural factors that affect risk-taking behaviors among construction workers. By understanding the motivations and pressures, the research intends to develop targeted interventions to mitigate these behaviors.

Ultimately, this thesis aims to contribute to the body of knowledge in construction project management by highlighting the critical role of logistics in fostering a safe working environment. The findings aim to support the development of better safety practices and policies that integrate logistical considerations, promoting a culture of safety and efficiency on construction sites.

1.2.1 Research Questions

RQ1: How does efficiency in logistics correlate with occupational health and safety on construction sites?

RQ2: Which aspects within construction logistics can be identified and measured to comprehend their impact on safety at a construction site?

RQ3: What are the key determinants that drive construction workers to exhibit a

willingness to take risks and bypass safety measures, specifically in the context of on-site logistics?

RQ4: In the context of complex projects, like Lilla Backa, what specific shifts in logistics planning are required and how do they effect the safety?

1.3 Limitation

- The research will be conducted over a limited period from January 2024 to May 2024.

- The study will focus specifically on logisticstools used in residential and commercial construction projects. Consequently, the logistics of infrastructure projects, which differ significantly in both workplace risks and logisticstools, will not be covered.

- The empirical research will exclusively examine the practices of Skanska. This narrow focus on a single company may not accurately represent the practices and challenges faced by other construction companies, especially smaller firms in the industry.

- The report will cover laws and regulations specific to Sweden, as well as the logisticstools used within the country. However, literature on why people take risks will be sourced internationally, without restrictions to specific countries. This focus on Swedish regulations and tools might limit the applicability of the findings to other regions with different legal and logistical frameworks.

2
Literature Study

In this chapter, the findings of the literature review are presented. The discussion begins with health and safety, followed by construction logistics. Each of these sections contains subchapters to provide a comprehensive overview of the topics explored.

2.1 Health & Safety

Occupational Safety and Health (OSH) is fundamental to every workplace, integrating preventive actions and protocols designed to protect the health and welfare of employees during toir work tasks. Whether in an office, manufacturing plant, or construction area, OSH is a crucial concept to maintain a safe and healthy working environment (Arbetsgivarverket, 2024). Hughes and Ferrett (2007) defines **Occupational health** as a practice that protects the physical and mental well-being of workers from workplace hazards. It emphasizes a holistic approach to prevent both physical and mental health problems, ensuring that work environments support general health. **Safety** focuses on preventing physical injuries, often overlapping with health to improve the general well-being of employees. Both concepts promote a culture that values comprehensive welfare, aiming for a holistic safeguarding of health and safety in the workplace.

When discussing occupational health, Hammar (2021) writes that it often refers to physical, psychosocial, and organizational conditions in the workplace that impact employee's health, safety, and well-being of the employee. This encompasses a wide range of factors, such as ergonomics, workload, job design, and the social climate in the workplace. With a healthy work environment, the aim is to minimize the risks of illness and accidents while promoting employee productivity and well-being. This involves creating a workplace where both physical and psychological stressors are kept at manageable levels, and where job tasks are clearly defined and realistic. Maintaining a good work environment requires collaboration between employers and employees. Employers must ensure that working conditions are safe and healthy, establish proper safety protocols, and offer essential training. Nevertheless, it is vital for employees to engage in occupational health matters by adhering to safety rules and reporting any potential risk, hazard or problems. A well-maintained work environment enhances employee health and well-being, boosts productivity, and lowers staff turnover. Additionally, fostering a positive work atmosphere is key to developing a sustainable and thriving organization.

Further, Hughes and Ferrett (2007) mention that the discourse on OSH often revolves around the discussion of hazards and risks. There is an important difference between them that is often confused. Hazard and risk refer to the potential harm posed by a substance, activity, or process. Hazards, such as chemicals or working from a ladder, vary in their potential danger. Risks, on the other hand, indicate the likelihood of harm occurring and can be reduced through effective management. Activities such as construction work are labeled as high risk due to high hazards. Despite the persistence of hazards, the implementation of controls reduces risks. The remaining level of risk after implementing controls, termed residual risk, indicates poor health and safety management and insufficient control measures when it is high.

2.1.1 Work Enviroment Act

To prevent health problems and accidents on the job in Sweden, the Work Environment Act (AML) applies to all work situations where an employee performs work on behalf of an employer. This law is in place to ensure that no one is exposed to danger in a workplace that could lead to health problems or injuries. In addition to preventing employees from being exposed to risks, it is the employer who bears the primary responsibility for establishing a safe and healthy work environment. According to Arbetsmiljöverket (2023c), workplaces with more than five employees should also have a safety representative, and this representative has the right to be informed about changes and reorganizations that affect the workplace.

Furthermore, the AML is complemented by numerous work environment regulations issued by the Swedish Work Environment Authority (Arbetsmiljöverket), which provides more detailed and comprehensive rules within the field of occupational health and safety. The Swedish Work Environment Authority's Collection of Regulations (AFS) aims to support a good work environment and prevent the risk of illness due to organizational and social conditions in the workplace. It should be highlighted that this report is published in 2024. However, as of January 1, 2025, the existing 67 regulations will be merged into 15 more extensive regulations. The 2,300 paragraphs from the current 67 regulatory booklets will be restructured within the 15 new regulatory booklets (Motodicum, 2024).

2.1.1.1 Safety-regulations Regarding to On-site Logistics

Some of these regulations can be seen in direct connection with loading and unloading. In Appendix 1, some of these can be found. They include, for example, that working conditions should be examined and risks assessed when lifting equipment and lifting gear are to be used, or if an operator of equipment for lifting freely suspended loads does not have a clear view of the entire lifting area, either directly or with the aid of equipment, a person competent for the task shall be in direct contact with the operator and guide them. The work shall be organized so that the load cannot move in a dangerous manner.

2.1.2 Accident in the Construction Industry

According to Arbetsmiljöverket (2023b) the construction industry is characterized by being one of the sectors with the highest number of serious accidents. The workplaces are temporary and sometimes mobile, which means that new conditions and therefore new occupational risks constantly arise. In their recent report on safety culture research within the construction industry, Berglund et al. (2023) assert that the complex nature of the construction sector underscores the need to address complexities such as those arising from the unique challenges posed by temporary and mobile work sites. In a typical construction project, many different stakeholders are often involved, from planning and design to production and completion. Effective planning is therefore required, where all involved parties collaborate and take responsibility to create a safe working environment during the construction phase and for the future use of the building or facility. Collaboration among different stakeholders is crucial to ensure that all aspects of the work environment are handled responsibly, ultimately promoting the safety and well-being of those involved in the construction process (Arbetsmiljöverket, 2023b).

In 2023, numbers from Arbetsmiljöverket (2024) reveals that the construction industry reported 3,857 workplace accidents out of a total of 38,323 and the number of fatal workplace accidents in the construction industry, in 2023, increased by 37.5 percent compared to the fatal workplace accidents in 2022. This marks the highest number of fatal accidents within the industry since 2010 (Arbetsmiljöverket, 2023a). These data indicate a continuing challenge regarding the workplace environment and safety within the sector, and according to reports from TT (2023) has been characterized as a dark year, with the construction industry standing out with 52 reported fatal workplace accidents. This significant increase in the number of fatal accidents underscores the need to thoroughly review and improve safety measures to minimize the risk of serious incidents within the construction industry.

In a report by Berglund et al. (2023), the authors investigated risks and safety practices within the construction industry, drawing on international research. The findings reveal a notable gap in Swedish research that focuses on risks and safety within the sector. Specifically, there is a deficiency in sociological perspectives on accidents in the construction industry, along with a lack of applied research on integrated systems involving subcontractors. The report underscores the urgent need for additional research, particularly examining the roles of developers and designers in occupational health and safety. Furthermore, the study highlights a poor utilization of research within the industry, with a majority of initiatives appearing to originate from researchers or authorities rather than industry stakeholders themselves. This insight emphasizes the imperative to bridge the gap between research and practice within the construction industry, aiming to enhance safety and occupational health more effectively.

According to a report by Taljegård (2022), specific behaviors, work procedures, and other factors significantly influence accident prevention. Furthermore, the report underscores the importance of a safe working environment and the use of technical

aids to facilitate cargo handling. Deficiencies in technical aids can increase the risk of accidents, particularly during securing cargo. Therefore, workplaces should conduct comprehensive risk analyses to ensure the proper use of technical aids, minimizing potential risks. Responsibility allocation and communication are intertwined factors that are crucial to ensuring safety during loading and unloading. Clearly defining responsibilities is essential, but equally important is fostering an open communication culture. This ensures that the right information reaches the right individuals, guaranteeing safe cargo handling and preventing potential accidents. In conclusion, standardized workplaces and the use of mobile loading docks can contribute to creating uniform and secure environments for loading and unloading. Pursuing standardization and ongoing enhancement of work procedures can greatly diminish the incidence of accidents during loading and unloading. By incorporating these findings into everyday logistics operations, companies can foster a safer and more effective cargo handling setting, thereby reducing the likelihood of accidents.

2.1.3 Factors Influencing Risk-taking Behavior

In the article *Factors Influencing Unsafe Behaviors and Accidents on Construction Sites: A Review* the authors have through a review of which factors influence unsafe behaviors and accidents on construction sites come up with a conceptual framework for the factors that influence the issue, see figure 2.1.

To formulate this framework, insights and findings from an analysis of 56 pertinent previous studies were examined. Through this framework, researchers and practitioners can acquire a deeper understanding of the factors influencing safety performance. The following is a summary of the eight factors that, according to the report, influence unsafe behaviors and accidents on construction sites (Khosravi et al., 2014).

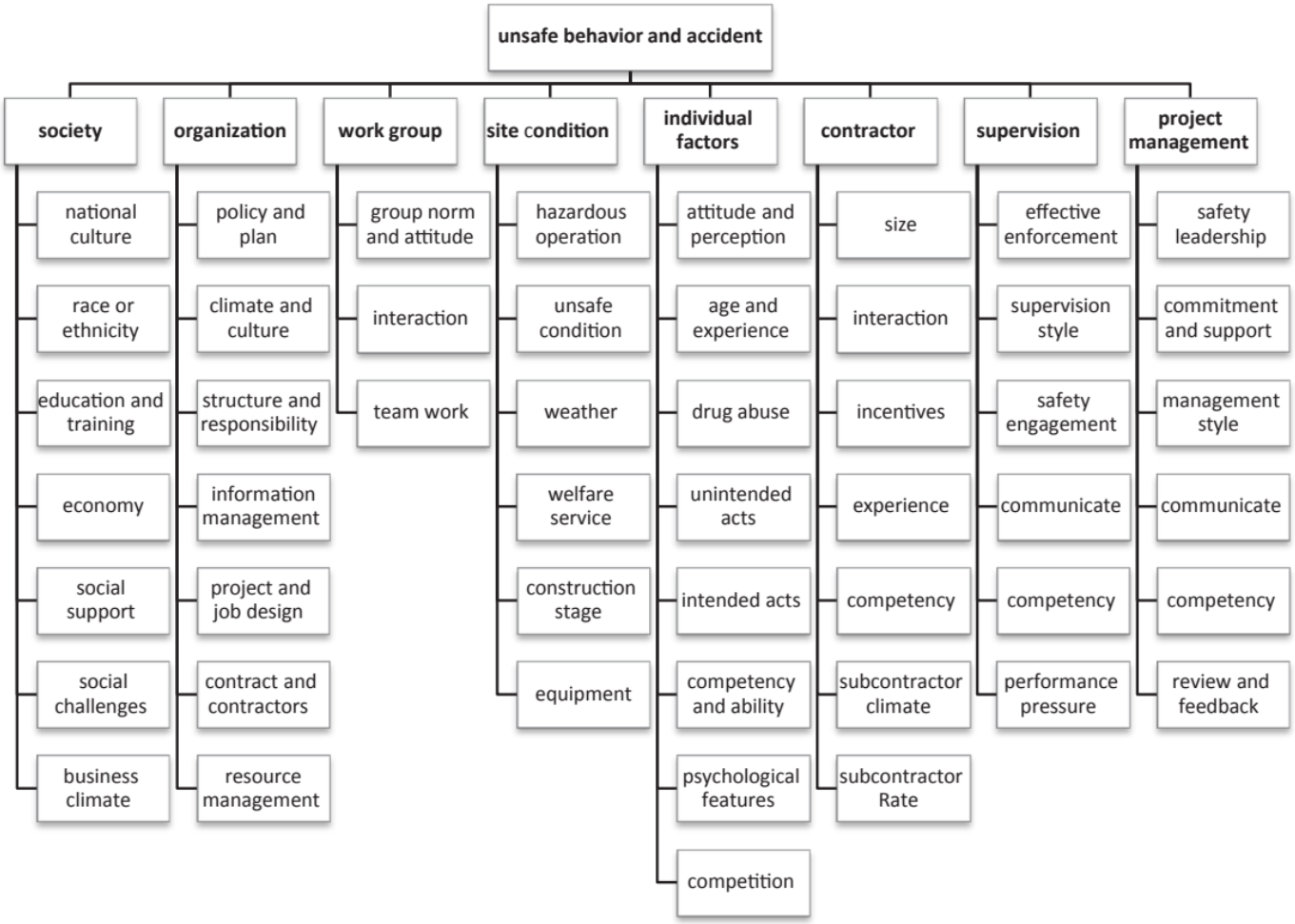

Figure 2.1: Conceptual framework for factors influencing unsafe behaviors and accidents on construction sites (Khosravi et al., 2014)

- **Society:** The text explores societal influences on construction safety, including cultural, racial, educational, economic, social, and business climate factors. Studies highlight these influences on unsafe behaviors, with examples such as national culture and local worker issues. In a market-driven society, lower supply chain stakeholders often prioritize project completion over safety. Insufficient social support is identified as an occupational stressor. Suraji et al. (2001) explain societal impacts, citing external pressures distracting workers and clients imposing constraints during project conceptualization. This sequence of causes and effects may intensify constraints on workers due to poor construction planning or management, resulting in hazardous conditions, behaviors, or activities.

- **Organization:** Previous studies have extensively examined how organizational factors impact safety performance on construction sites. The organization emerges as a key influence of unsafe behaviors and accidents, with seven prominent themes that show negative associations: policy and plan, safety climate and culture, structure and responsibility, information management,

project and job design, contract management, and resource management. The safety climate, often used interchangeably with the safety culture, is a multidimensional construct, focusing on individual perceptions rather than comprehensive aspects of the safety culture. In the construction industry, it is commonly observed that organizations tend to align more with the organic model rather than the mechanistic one. This is due to the dynamic nature of the work environment, where factors such as tasks at hand, working conditions, and general conditions at the job site undergo frequent and often rapid changes. Unlike mechanistic organizations, which often prioritize strict adherence to predefined rules and procedures, organic organizations in construction place greater emphasis on flexible decision-making processes. They recognize the need to involve decision-making roles that can adapt to evolving situations. In addition, organic organizations rely heavily on the expertise and skills of their workforce, encouraging a culture of empowerment and participation in decision-making processes. Additionally, they invest in comprehensive training facilities to equip workers with the necessary skills to tackle non-standardized operations effectively.

- **Work group:** The literature indicates that these factors, particularly within the theme of work group, show a low evidence of an uncertain association with unsafe behaviors and accidents. Group norms, representing accepted attitudes within a group, play a crucial role. Establishing positive attitudes toward safety within a group is fundamental for successful safety management and forms the basis of a robust safety culture. However, much of the previous research has been descriptive, and there is a recommendation for future studies to delve deeper into this theme, particularly within the context of group work.

- **Site condition:** The conditions on a site frequently develop within environments that are dynamic and subject to rapid change, as depicted in Figure 2.1. Unsafe conditions, hazardous operations, unsafe equipment, and adverse weather conditions demonstrate moderate evidence of being associated with unsafe behaviors and accidents. Construction tasks inherently carry risk due to outdoor operations, work at heights, complex site layouts, and equipment operations, compounded by workers' attitudes towards safety. However, many studies in this field primarily use accident records as their data source, which could result in underestimating errors. Additionally, site conditions, such as individual features, are often seen as immediate factors rather than distant ones. This underscores the importance of exploring the underlying factors that contribute to unsafe conditions on construction sites.

- **Individual factors:** The emphasis on individual factors in previous studies highlights their significant role in the influence of unsafe behaviors and accidents. Through content analysis, seven themes emerged: attitude and motivation, age and experience, substance abuse, unintentional actions, intentional actions, competence and ability, and psychological distress. Among these individual characteristics, the attitude and motivation for safety, as well

as age and experience, showed moderate evidence that they were positively associated with unsafe behaviors and accidents. Many studies indicate that inappropriate actions, such as unsafe practices, improper use or nonuse of provided personal protective equipment, and taking shortcuts, are immediate causes of construction accidents. For example, Suraji et al. identified inappropriate operative actions as proximal factors rather than distal factors (Suraji et al., 2001). Proximal factors, such as workmanship deficiencies, may be the result of violations rather than being the root cause. Thus, there is a clear link between individual characteristics and other distant factors that influence unsafe behavior and accidents on construction sites.

- **Contractor:** Six factors, including contractor size, interaction, incentives, competency, subcontractor climate, and subcontractor rate, showed moderate evidence of being linked to unsafe behaviors and accidents. In particular, there was a significant negative correlation between contractor size and accidents. Research indicates a negative relationship between fall accidents and company size. Similarly, another study found that unsafe behaviors were negatively correlated with employer size. However, larger companies, which often rely on subcontractors' pools, tend to prioritize cost in contract tenders, leaving little room for investment in occupational health and safety. Although subcontractors are typically responsible for their workload, any safety deficiencies lead to immediate repercussions for the main contractor. Many studies in the construction sector have focused on general contractors, underlining the importance of gaining a deeper understanding of the role of subcontractors in the influence of unsafe behaviors and accidents on construction sites.

- **Supervision:** Six themes, encompassing effective enforcement, supervision style, safety engagement, communication, competency, and performance pressure, were identified in this category. Notably, effective enforcement, worker-supervision communication, and a positive supervision style demonstrated moderate evidence of a negative association with unsafe behaviors and accidents. Research emphasized the correlation between supervision and safety performance, while other research highlighted factors related to supervisors, such as a lack of feedback, poor communication, poor relations with superiors, and inadequate managerial support, as significant causes of occupational stress reported by workers. Work pressure, statements like "hurry up", and the urge to finish work quickly are likely more associated with supervision style than contributing to an increase in unsafe behaviors and accidents. Furthermore, previous research generally agreed on the beneficial effect of strong enforcement on safety performance at construction sites.

- **Project management:** Six themes, including safety leadership, management commitment and support, management style, safety communication, competency, and review and feedback, were found to have substantial evidence of a negative association with unsafe behaviors and accidents. Numerous studies underscored the pivotal role of management commitment in enhancing

safety performance and reducing accidents. Safety communication was another crucial theme examined in prior studies, encompassing toolbox talks with managers, worker-manager communication about hazardous situations, and management's discussions on safety. However, a common critique of much literature concerning the relationship between project management factors and unsafe behavior is the lack of clarity regarding the mechanism of their relationship.

Furthermore, additional research supports the validity of Khosravi et al.'s findings. For example, in the article, *Why operatives engage in unsafe work behavior: Investigating factors on construction sites*, Choudhry et al. (2007) has done an empirical research in Hong Kong where they have investigated why construction workers engage in unsafe behavior. This investigation sheds light on the reasons behind unsafe work behavior among construction workers in. Explores theories of accident causation and human error, conducting in-depth interviews with accident victims to examine causes and attitudes of workers towards safety. Eleven factors influencing safety behavior are identified;

- management
- safety procedures
- psychological features
- economic aspects
- self-esteem
- experience
- performance pressure
- perceived risk
- working environment
- job security and education
- orientation and training

A study conducted by Low et al. (2019) investigates the risk-taking behaviors of construction workers, finding that those with a positive attitude towards risks or high cognitive bias are more likely to engage in unsafe behaviors, while those with greater risk awareness avoid dangerous activities. Enhancing work conditions, such as providing adequate lighting and safety equipment, significantly reduces risk-taking behavior, highlighting the importance of investing in safer work environments. Although the overall safety climate within the organization did not show a significant direct effect on risk-taking behaviors, a negative correlation was observed, implying an indirect role in fostering safer practices.

2.1.4 Measuring Safety

According to the findings of Deepak and Gangadhar (2019), accurately identifying and selecting measurement instruments is crucial to evaluate safety culture within organizations. In practical applications, an effective measurement tool is necessary to measure the level of safety culture. Assessment of safety culture in various sectors typically involves the use of quantitative questionnaires, which incorporate a variety of factors outlined in the preceding section. Among the various measurement tools available, the Safety Climate Assessment Tool (S-CAT) stands out as a comprehensive assessment tool specifically tailored for the construction industry. Developed based on recommendations and input from multiple stakeholders in construction projects, S-CAT serves as a holistic tool that contractors can use to enhance the safety culture at their job sites.

With extensive input from the construction industry, researchers at CPWR (2023) and Washington State University Vancouver developed the S-CAT, which companies can use to assess their progress towards strengthening eight leading indicators of safety climate:

1. Demonstrating Management Commitment
2. Aligning and Integrating Safety as a Value
3. Ensuring Accountability at All Levels
4. Improving Supervisory Leadership
5. Empowering and Involving Employees
6. Improving Communication
7. Training at All Levels
8. Encouraging Owner/Client Involvement

Cohen (2002) suggests that conventional safety measures are retrospective, meaning that they are assessed after incidents have already taken place. These measures are commonly referred to as reactive, trailing, downstream, or lagging indicators, as they depend on historical data. Centering attention on such measures, such as accident rates and compensation costs, frequently results in an evaluation of safety success based on the extent of system failures.

2.2 Construction Logistics

CIVIC (2018) describes that all construction projects require materials, personnel, and equipment to be delivered to site, in addition to this time and location of deliveries are crucial to achieve an effective logistics solution. Furthermore, construction logistics differs compared to other industries as site disposition changes for each project, deliveries are based on the phase the construction is in rather than recurrent, the way activities are performed in sequence and the fragmented nature of the industry. According to Sullivan et al. (2011) construction logistics became its own discipline during the 1980s during the rise of construction management when the clients started to procure directly with specialized subcontractors for activities that were considered as non core construction activities in combination with a project management contractor for the construction. Examples of these activities brought up that are not construction logistics specialists are waste management and housekeeping. However, the authors states that the industry still has problems with inefficient logistics. Other industries have experienced an increase of upward of 20% in working capital by implementing well-thought-out logistics, and current logistics specialist companies are stating that contractors can save up to 15% in costs of materials and labor by implementing just in time deliveries. Sezer and Fredriksson (2021) explains that construction logistics can be divided into two different categories, on-site logistics and off-site logistics. The off-site logistics are the activities that relates to tasks outside the construction site, one example of these is planning of deliveries. On-site logistics are the activities that take place on the site, examples of this are the loading/unloading process and material handling on-site.

Both categories of construction logistics must be included in all phases of construction according to Sullivan et al. (2011), but the most important phase for an effective logistics solution is the planning phase. During this phase the construction site and its different compositions have to be taken into consideration when developing the logistics plan. But additionally the surrounding areas and possible obstructions from the local businesses, neighbors, traffic, and more need to be taken into consideration. Production management should then implement the logistics plan developed during the different construction phases in the project. Additionally, for a better logistics plan, the employees that are going to do the activities planned should be considered during the planning phase.

Additionally, the planning phase in any project is where possible changes are as cheap as they will ever be, as well as the easiest to implement, as shown in Figure 2.2.

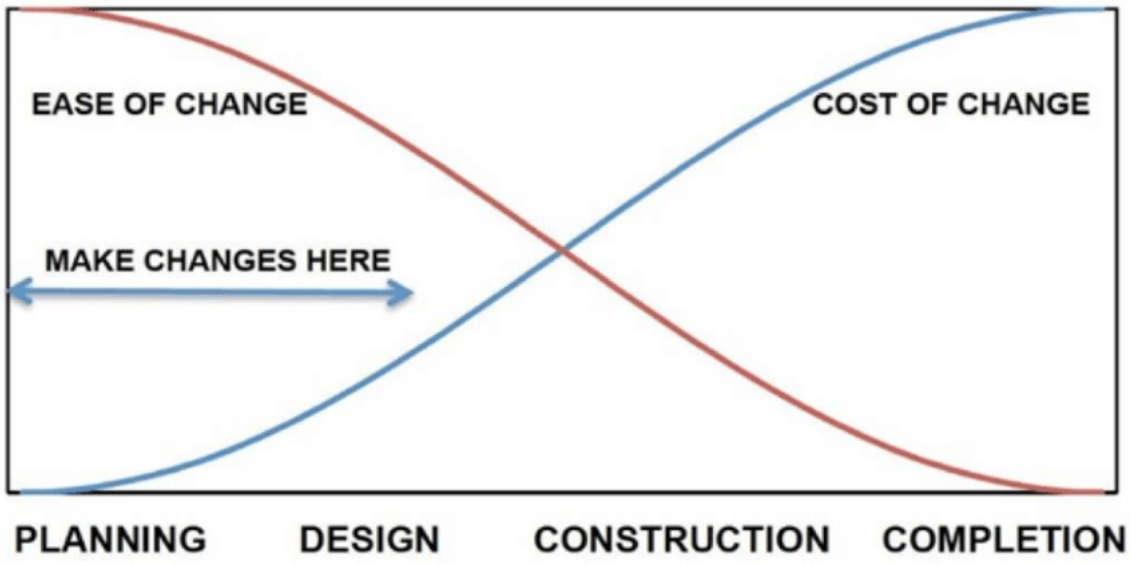

Figure 2.2: Cost influence curve (Prieto, 2022)

In addition, construction logistics must be integrated into the project supply chain to achieve smooth off-site logistics. The supply chain suffers from the same problem as the construction site, with fragmentation and the uniqueness of every project (Vrijhoef & Koskela, 2000). According to Agapiou et al. (1998) the way to handle this optimally needs to be planned during the planning phase but also executed by the purchasing department as planned. Current practice is less optimized and most materials are ordered when needed during the production phase more often than planned in advance.

2.2.1 Logistics Tools and their Advantages

Traditionally deliveries to construction sites are not planned in advance and a common practice is that deliveries take place the day after ordering according to Dubois et al. (2019). Because of this it is common to see non-filled up trucks backed up waiting for their turn to unload their goods. In the opposite case, if the deliveries are filled properly, it can cause the site to be backed up with materials that have long waiting times until they are supposed to be used. The authors continues describing that materials are often stored in inappropriate areas and moved around when needed, which can cause damage by either the handling itself or inappropriate storage. Their suggestion is to implement a logistics coordinator as a tool to try an counteract this, to ensure that deliveries do not arrive at the same time and causes delays, the coordinator can apply the usage of time slots. Time slots work by assigning deliveries to specific time slots when they can arrive, preventing trucks from arriving at the same time, easing the stress on the material handling. Additional requirements can be placed on the deliveries by the logistics coordinator, and one example is packaging, by receiving deliveries that are packaged in a way that ensures that both materials can be delivered directly to the place of installation while reducing the probability of damages. According to Dubois et. al. the solution

of implementing on-site coordinated logistics has proved to be effective in previous projects, with studies showing a decrease in the time allocated for the material handling of gypsum boards 42%.

2.2.1.1 CCC

Looking at construction logistics from a wide perspective, Janné and Fredriksson (2019) explains that Construction Consolidation Centers (CCC) can be used to reduce the amount of deliveries by consolidating deliveries before the trucks start their journey towards the site. It works by having a facility outside of the construction site that receives the deliveries that otherwise would go directly to the site and stores them until they are supposed to be delivered to the site. The transports are then loaded and consolidated when the delivery is booked by the project. This requires some sort of joint coordination of booking deliveries, mainly done through an IT platform, forcing actors that are against change to participate. The services provided by the CCC can vary but one example of an additional service that certain CCC:s offer is kitting. Kitting is when the materials for one part of a project are combined into a package that can be delivered directly to the place of installation instead of needing to sort the materials on-site. A limitation with CCC:s is that the advantages come mainly with materials/goods that are smaller as deliveries of larger such as pre-fabricated concrete elements do not benefit of the consolidation.

However, according to Browne et al. (2019) a CCC facility has the possibility of increasing the standardization of the vehicle type that arrives at the site, varying types of trucks can increase the time allocated to unloading and the standardization can decrease the delays of material deliveries for contractors. The authors also explains that there is a lower risk of material damage as the CCC stores the materials in secure and dry conditions. Furthermore, if the materials aren't used a CCC has the possibility of removing surplus materials from the site.

2.2.1.2 TPL

Janné and Fredriksson (2019) exaplins that the most common solution is that a CCC is run by a Third Party Logistics (TPL) provider, but a TPL can also provide other services in addition to a CCC, the most frequently used service being outsourcing of material handling. The most common current practice for material handling is that craftsmen on site take care of materials handling when needed or when they have time between their traditional value-adding activities according to Lindén and Josephson (2013). The alternative of outsourcing the on-site logistics to a TPL provider presents one important difference, and that is that when utilising outsourcing the work can take place outside of normal working hours, contributing to less disturbances for the logistics team. Lindén and Josephson's study shows that during normal working hours, unloading of deliveries can have multiple disturbances in just one hour of work, whereas deliveries outside of working hours had none. The study showed that outsourcing had an advantageous effect on logistics in housing

projects, reducing the total cost of a bundle of gypsum from 295,3€ to 251,7€. However, the TPL provider self-states that the advantages with outsourcing are most prominent when there is low uncertainty and when the production teams structure their production more efficiently.

A further benefit that Janné and Rudberg (2022) brings up is that the usage of TPL material handling can also decrease the amount of material stored on site by ensuring that the materials are only transported to site once it's needed. This makes sure that the construction site is more structured, tidy and clean from a material perspective. This increases the productivity and reduces material related accidents while decreasing the total cost of operations.

2.2.1.3 Logistics Plan

The planning of logistics on site is a principle that can substantially reduce material costs according to Agapiou et al. (1998), they bring up a study conducted by the Danish Building Research Institute the planning saved a total of 5% of the construction cost.

The logistics plan should include tools and guidelines that can help and guide actors through the construction process according to Serra and Oliveira (2003). In table 2.1 their guidelines and tools for different production cycles are presented, to optimize the construction site efficiency these should be prepared beforehand and followed during the production. However, one important aspect is to allow for feedback during the process as well as gathering information from the experience and reuse this for future improvements. Furthermore, it's recommended that a specialized logistics manager is appointed to be responsible as there is a risk of overloading a manager with functions otherwise. According to the authors the overall result of a successful implementation can be that the company becomes more competitive as they reduce non-value adding activities and maintaining a higher degree of control over the material flows .

Table 2.1: The guidelines and tools that a logistics plan should include (Serra & Oliveira, 2003)

Production cycle	Guidelines and tools
Design	- Logistics guidelines for the conception - Analysis of the technological alternatives - Definition of the plan of attack for on-site work - Production design - Site design - As-built design
Planning	- Gantt physical chart - Gantt materials consumption chart - Gantt equipment chart - Histogram of own labor - Gantt subcontractor chart - Gantt chart of implementation of work-safety related preventative measures
Supplies	- Materials specification - Plans for materials deliveries to the site - Gantt chart of the startup of the purchasing process (quotations) - Materials/suppliers purchasing rules - Materials and services supplier qualification - Guidelines for equipment purchasing or leasing - Use of indices of material losses and wastage
Execution	- Plan for the execution of work on the floors - Documentation, implementation and maintenance of the information system - Use of labor and equipment productivity indices - Work safety and health rules

2.2.1.4 Delivery Plan System

A construction site often has restrictions when it comes to available space, and when the site is located in the city center, the restrictions often become even worse according to Sullivan et al. (2011). Most often, deliveries are restricted to a 10-hour daily window. Violating these restrictions can damage relationships with neighboring properties and may even lead to the revocation of unloading permits due to noise disturbances. The transport companies generally want to deliver in the morning in order to avoid as much traffic as possible, but because of this the unloading areas become chaotic during deliveries and are empty in the afternoon. Logistics managers want an even flow of deliveries during the day to utilize the unloading areas as much as possible while still making sure that its a smooth process. This is where a digital delivery planning system comes into the picture, a good digital program will let you see what time slots are available for deliveries and what site resources are free for helping the unloading process. Furthermore, the software will tell you if the booking has conflicts in the system, preventing unnecessary headaches. This can also reduce the amount of materials stored on site as contractors are encour-

aged to order less excess materials. One example of this is when a previous delivery gets misplaced on site and is not found rather quickly then the person requiring the material just orders more. When the slots need to be booked beforehand this might have a more severe delay than just searching more thoroughly and finding it. However, the rules regarding the booking system needs to be firm and enforced for it to work, the logistics manager therefore needs to be prepared for conflicts and stand his or her ground with either contractors or transporters regarding late trucks, unbooked deliveries, and more. There needs to be a system to prevent booked time slots not being utilised as they are missed opportunities for other deliveries to take place.

2.2.1.5 Labeling of Goods

The label on a transport pallet can, according to Fredholm (2014), include a multitude of different types of information down to where the pallet is supposed to be placed on a construction site. The labeling plays a role for both the transporter and the receiver, the transporter can obtain information like how the pallet is supposed to be loaded and what goods are to be grouped together. On the receiver side, the pallets should already be sorted correctly and can be transported directly from the trucks to the place of installation, reducing the time needed for temporary storage or accidental misplacing of goods. This also reduces the time construction workers must spend sorting materials or searching the site for the materials needed for their current work. One step further is to use radio frequency identification (RFID) tags on the materials coming to site and sensors placed on the site to better be able to locate materials or track goods in the supply chain. However, RFID's are an added cost and there are some gaps in the technology, for one the signal can be interfered with by metal and concrete (Valero et al., 2015).

2.2.1.6 Resource Management

From case studies done by Kusimo et al. (2019) seven different aspects that contributes to insufficient resource management within the construction industry, these are: poor understanding of project complexity at the tender stage, incomplete survey of the project site, little visibility of resource profile at the tender stage, changes to project schedule, running multiple projects in parallel, shortage of specialised resources, and poor management of client specific authorisations and certifications. They continue to describe that in certain cases, the client uses certification of resources as schemes to reduce machine hours for contractors that have machines without certification. This can cause contractors to use less resources than necessary and in turn cause health and safety hazards. But in order to increase the effectiveness of resource management on construction sites the authors explains that the most common tool to use is a digital software, the software's aims to provide accurate time, cost, and schedule allocations to the project. The current practice do lack the ability to allocates between multiple projects showing what resource might be in demand or waste. Furthermore, software often lacks the ability to show real-time updates or take into account experiences from previous projects.

2.2.1.7 Supplier Collaboration

Akintoye (1995) explains that within the construction industry the contractors generally focuses more on their relationship with the clients than the suppliers in the supply chains. The idea of supplier collaboration is that the two parties work together in a way that results in higher efficiency, better products, and higher levels of productivity for both parties. Other industries have already implemented closer collaboration with the actors in their supply chain with success, but there is a bigger challenge with the construction industry. Due to the shifting conditions between sites, the collaboration needs to be focused on the aspects of the different projects rather than organization. The main barrier to implementation in the industry is the lack of top management commitment and to reduce this, tools like education and re-orientation can be of use (Akintoye et al., 2000).

2.2.2 Takt Planning

Takt planning or takt-time planning is the the overall progress rate that the activities on a construction site are ideally supposed to follow according to Haghsheno et al. (2016). Takt has been used in different industries since the 16th century where ship production was in high demand and has been utilized for its benefit since then. However, the author states that takt planning was not used within construction until 1930 during the construction of the empire state building. Takt planning is done by dividing the construction into different detailed work steps that has their own performance factors, the amount of man-power and more and results in the total time required for each activity. The activities are then planned in a way that matches the overall project structure making sure that buffers and activities align. Haghsheno et al. suggeststhat in order to utilize the most of takt planning collaboration between the whole project team is required. The plan should be customized during the project to make sure that the current plan is in line with the actual production making sure that for example the performance factors are align with reality. The benefits of using takt planning is increasing a projects long term effectiveness as well as stabilising the production systems on construction sites.

2.2.3 Implementation Difficulties

But why is construction logistics not implemented widely in the industry? Lindén and Josephson (2013) explains that the construction industry has the reputation of being slow in adapting, and this is definitely the case when it comes to utilizing construction logistics, and one reason presented is the culture of the industry. The culture is described as conservative and hostile to change, and this combined with small profit margins and a tight time constraint on projects leads to even fewer initiatives. This in turn means that the only methods that are used are those tested and tested in the past, since the results are already known. Furthermore, Sullivan et al. (2011) states that the relatively small profit margins combined with the fact that the cost of logistics is usually hidden behind other costs makes a logistics solution seem like a very expensive option for something that already exists. Dubois et al. (2019) metions other concerns that have also been expressed by subcontractors is

the fact that it gives them less flexibility and requires more time allocated to the planning of deliveries.

In addition, Sullivan et al. (2011) mentions that adequate communication is a huge requirement between the project and everyone with some kind of logistics responsibility. This is often not as straightforward as it sounds, and possible barriers can be contractual or cultural. Contractual barriers can not always be circumnavigated and need to be evaluated during the procurement phase, but cultural barriers can be harder to define, one example is the way we speak. One person might call a certain grain of sand one word while for others that word means something different, this can cause problems in the logistics of a project with faulty orders and delays.

2.2.4 Construction Logistics and Worker Safety

When a project implements a logistics solution that plans how vehicles are supposed and allowed to travel on and around the site some benefits have been explored in relation to safety according to Lindholm and Browne (2015). One benefit found with a more controlled environment is that the loading/unloading of deliveries is guaranteed to be legal to a greater extent, and delivery drivers are only allowed to unload at certain loading/unloading areas. Furthermore,Sezer and Fredriksson (2021) suggest if a vehicle has a longer turnaround time when loading or unloading it increases the risk of an accident, a more optimal logistics plan should have the effect of deceasing the turnaround times and thus deceasing the risk of an accident.

Additionally, Sullivan et al. (2011) mentions that the safety in the loading/unloading areas can benefit by utilizing well trained and equipped personnel for the material distribution on-site. This can be achieved by having appointed employees taking care of only the material handling or by utilizing third party logistics. The safety regarding materials can be further enhanced by having a CCC, a project using a CCC is generally less structured when it comes to material storage and causes fewer obstructions for construction .

Furthermore, studies by Ismail et al. (2012) have shown that the main factor that affects a safety management system on a construction site is the personal factor, and the most important factor within the personal factor was safety awareness. Risk awareness was shown to depend on good communication and this was the result of strong managerial support.

2.2.5 Logistics in Complex Projects

Ekeskär et al. (2022) suggests that the construction industry lacks cooperation between main contractors, to improve logistics on construction sites that involve multiple actors there is advantages of utilising TPL suppliers to manage the on- and off-site logistics. They state that a TPL can facilitate a reconfiguration of activities by taking the responsibility of handling the materials and resources that are used

on-site like elevators. Handling materials after the traditional working hours reduces interference between construction work and logistics, as well as increasing the time that construction workers can spend doing their job. Additionally, this causes less rifts between actors as they are not competing over time to use the elevators for material transport and that the TPL coordinates the activities with all actors. Furthermore, when construction workers do the materials handling it is rarely planned beforehand and rather done between their pre-planned work tasks. A additional benefit mentioned by the author is that removing this also benefits managers as there is less time putting out fires because of materials needing to be transported. However, there is instead a need for more planning of the coming construction activities to make sure that the logistics teams knows what materials are needed. Furthermore, Ekeskär et al. mentions that the logistics team require a certain degree of resource combining with the contractors with equipment needed to move materials, and this has the benefit of utilizing the machinery to a greater extent as long as the material handling after working hours. This benefits the contractor as well as they get additional revenue where they would not have the possibility to otherwise. If the TPL provider includes a CCC in their service on top of this the storage on-site will be reduced in combination with the amount of deliveries. A further benefit is that the CCC forces contractors to increase their communication with their suppliers to ensure that the information provided is correct.

2.2.6 Delivery Difficulties

The deliveries to a construction site is a big part of construction logistics as a whole, Fredholm (2014) explains that there exists many different difficulties related to the deliveries and presents the difficulties by dividing them into three different areas.

The first area of difficulties that Fredholm (2014) mentions is the need for more efficient information exchange. Firstly, there is a disconnect between the supplier and the customer when it comes to the delivery occasion as they view it from different perspectives, the supplier thinks the delivery is done when it leaves their facility while the customer thinks that the delivery is finished once it arrives on the construction site. But this is not the only reason behind confusion between the parties as sometimes the customer doesn't even set a desired arrival time or a date that is too soon and might be very challenging for the supplier to meet. Furthermore, the site conditions sometimes change making the customer want a different delivery time, if this happens close to the delivery date it can cause issues for the suppliers operation. Changes in delivery time and other requests are often done by phone and usually there is not only one inquiry, this communication can cause issues as information is often lost causing either more phone calls or lack of information within the delivery chain. Once the delivery arrive on site the conditions for unloading is not always met, this can be solved by additional on-site resources but there are cases were the truck needs to return to a suitable reloading facility. To avoid a lot of the issues mentioned it's advisable to have a continuous communication with the supplier regarding the order and delivery information and not wait until the last moment in order to see what the site conditions will be like.

The second area is the need for a more efficient organization, Fredholm (2014) explains that one of the aspects of this area is the lack of resources when it comes to handling the deliveries. This is a bigger issue in smaller projects but can be based in personnel having to much on their plate or not being staffed continuously as well. When it comes to planning the deliveries, the procurement department plays a role in but often at a very early stage. The planning is often done weekly, but in reality they should be planned daily or even specific time windows. Furthermore, the recipient often varies and most sites have implemented on specific goods receiver and when there is multiple subcontractors on-site this can cause problems. Lastly, the contact between the driver and the site can cause problems if the driver is handed a faulty number or that the person is unavailable.

The third and final area is the need for more efficient interfaces for transport routes, the first aspect is having a usable delivery schedule. For many other industries this isn't as much of a issue but the construction industry with it's project based operation this becomes a vital aspect to think about. The second aspect is the way the delivery drivers can notify the site of their arrival, this becomes especially important when the recipients often are not customers to the freight handling company (Fredholm, 2014).

3
Methodology

This chapter details the methodology used in this thesis. It begins with an explanation of the research approach, followed by a comprehensive literature study. The empirical study is then presented, including the methods of data collection and analysis. The chapter concludes with a reflection on the quality of the research.

3.1 Research Approach

For this thesis, a qualitative approach was selected, as it is deemed more suitable for examining aspects related to social science, such as attitudes, compared to the quantitative approach. According to Bell et al. (2019), using qualitative methods, you can gain a better understanding of the social, cultural, and organizational factors that shape the interface between logistics and safety, which ultimately leads to more contextually relevant and actionable insights to improve safety practices within logistical operations. Given that research questions include elements of social studies and the need to understand the underlying reasons for the interaction between logistics and safety, the suggestion of Silverman (2006) a qualitative methodology was considered the most appropriate alternative. The interaction between logistics and safety involves multifaceted human behaviors, decision-making processes, and organizational dynamics, which are often difficult to capture solely through quantitative measures. Unlike quantitative data, qualitative methods allow researchers to delve deeper into the nuances of these interactions, exploring the underlying motivations, perceptions, and contextual factors that influence decision-making and behaviors related to logistics and safety. For example, understanding why certain safety protocols are adhered to certain logisticoperations more strictly or uncovering the underlying cultural norms and organizational practices that impact safety outcomes often requires qualitative research. In addition, qualitative approaches provide the flexibility to adapt to the dynamic and complex nature of logistics and safety contexts, allowing researchers to capture emerging phenomena and unanticipated insights that quantitative methods might overlook.

3.2 Literature Study

As a large part of the research focuses on the relationship between safety and construction logistics and the limited research that exists currently, an abductive approach was chosen as this approach is, according to Dubois and Gadde (2002),

suitable for discovering new variables and relationships. Furthermore, an abductive approach allows the researchers the possibility to provide context for empirical findings that were identified after the initial literature review.

The literature review was initially based on the Construction Logistics and Supply Chain Manager Course Literature (ACE130), the sources used by the authors of the literature were also further examined, and this examination provided greater insight into keywords and other related terms. Some of the keywords identified were *construction logistics*, *safety*, *construction industry*, and *logistics tools*. Keywords were combined in different ways to identify the relevant literature in the databases used. The ones used during the literature review were Chalmers Library, Google Scholar, and Digitala Vetenskapliga Arkivet (DiVa). Further research using these keywords provided a base for the formulation of interview questions and the choice of suitable topics to explore. Furthermore, additional literature surfaced during discussions with interviewees and supervisors.

The chosen literature was examined to ensure both relevance to the subject by reading both the abstract and the conclusion, as well as credibility by checking the number of citations by other authors. Information collected from government websites was considered without taking into account the number of citations taken into consideration based on the trustworthiness of the official status of the sites. After the empirical study, the abductive approach was used and the literature review was revisited to contextualize certain new empirical findings.

3.3 Empirical Study

The empirical study consists of 12 semi-structured interviews. These interviews provide the thesis with empirical material focused on the topic discussed. At the same time, they give interviewers the freedom to explore relevant ideas that may surface during interviews. This approach has, according to Adeoye-Olatunde and Olenik (2021), the possibility of improving the understanding of the subject in question.

Prior to conducting the interview study, biweekly meetings were held with the Skanska supervisors. These meetings served to impart a comprehensive understanding of Skanska, guidance on where to source pertinent information, and recommendations on whom to interview. In addition, a dedicated session was arranged with a project manager, offering valuable information and facilitating connections with suitable interviewees in various on-site positions. To add an academic perspective to our study, we identified an associate professor specializing in work science through our literature review.

The interviews were conducted in person or online, depending on the availability of the interviewees and their geographic locations. To accommodate the respondents' convenience, the interviews were conducted in Swedish.

3.3.1 Interview Respondents

To explore the details of logistics and safety measures, individuals in various roles were consulted to gain information. This method aimed to capture a comprehensive range of experiences and perspectives, thereby shedding light on differing viewpoints. The roles of all interviewees are presented in table 3.1, listed in the sequence of their interviews.

Table 3.1: Lists of respondents and their respective roles, company and mode of interview

Intervieews			
No.	***Role***	***Company***	***Interview mode***
1.	Regional Health and Safety Manager	Skanska	Onsite
2.	Health and Safety Leader	Skanska	Onsite
3.	Production Manager	Skanska	Digital
4.	Logistics Engineer	Skanska	Digital
5.	Logistics Engineer	Skanska	Digital
6.	Logistics Engineer	Skanska	Onsite
7.	Construction Supervisor	Skanska	Digital
8.	Logistics Engineer	Skanska	Digital
9.	Team Manager logisticsTeam	Skanska	Digital
10.	Construction Supervisor	Skanska	Digital
11.	Logistics Engineer	Skanska	Onsite
12.	Associate Senior Lecturer in Work Science		Digital

Interviewee 1 is responsible for ensuring that all workplaces meet legal requirements and that all employees adhere to safety regulations. They are also responsible for training staff in safety matters and maintaining oversight of safety protocols and procedures. Additionally, they are responsible for investigating and analyzing the causes of accidents and taking measures to prevent their recurrence.

Interviewee 2 primarily works with preventive measures regarding health and safety work. They support these functions by providing both tips and advice on what to consider. Additionally, they conduct ongoing follow-ups to see how things are actually working.

Interviewee 3 holds the position of production manager and is responsible for leading and coordinating work at the workplace, including planning, execution, and production control. They also serve as the Site Manager for the current project.

Interviewee 4 is a logistical engineer and works with the task of supporting projects within Skanska with logistics such as helping with a logistics plan as well as developing internal logistics related projects in all of Skanska.

Interviewee 5 works as a logistical engineer within Skanska, the work consists of helping projects get a effective material supply utilizing different logistical tools and

knowledge regarding logistics as well as developing the tools further.

Interviewee 6 is a logistical engineer oriented towards Skanska's infrastructure and industrial projects, the main tasks are developing a material handling program and implementing this. This includes a lot of digitization of current practices to increase effectiveness and ensure more accurate tracking of excavation masses.

Interviewee 7 works as a supervisor in a construction project, currently they have the responsibility of the frame assembly. The interviewee has a background as a blue collared worker and completed a further education afterwards to become a supervisor.

Interviewee 8 is employed as a logistical engineer, the are within Skanska they work towards is the housing department. The work consists of three activities, contract subcontractors for logistical services, developing logistical solution and tools as well as supporting the construction project in logistical aspects.

Interviewee 9 is a team manager for the logistics group, they are a central function that works with all phases of construction from developing tools, working methods and solutions to supporting the projects with implantation of logistical tools or solutions.

Interviewee 10 occupies the role of supervisor and in their current project has the main responsibility of the masonry of the exterior. Scaffolding and the logistics when it comes to the materials surrounding the exterior is included. The interviewee has a background in blue collar work within Skanska and carried out further supervisor education within the company.

Interviewee 11 has the role logistics engineer and is responsible for scaffolding, water, electricity and heat for a projects as well as a IT responsibility. In their current project there will be a CCC that they have the responsibility for as well.

Interviewee 12 is an associate senior lecturer in work science at a technical university in Sweden, they have a background in sociology and is currently working with work science and equality mainly focused towards the construction industry.

Some of the logistics engineers are part of a group called the **logistics group**, the goal of this group is to streamline supply chains and information flows within Skanska's projects through the development of processes and tools, providing specialized services for material handling and procurement of freight arrangements. In the interview study, 5 of the logistics engineers are part of this group and they are: Interviewees 4, 5, 6, 8 and 9.

3.3.2 Etichal Considerations

To address ethical considerations, interviewees were asked for consent to be audio-recorded to ensure the integrity of the empirical material presented in the thesis. In addition, they were given the option to anonymize any additional information beyond their names, considering that in some cases there might be only one person in a particular role, making identification relatively straightforward. Furthermore, each interview commenced with an explanation of the purpose and scope of the research, as well as the interviewee's role in the study. At the end of each interview, participants were assured that they could request revisions or provide additional information if desired. In addition, to guarantee accurate quotes, factual correctness and interpretation of the results, respondents were allowed to choose to review the interview results in the report prior to publication. These measures were implemented to ensure the comfort and security of the participants and to gather high-quality interview data.

3.4 Analysis & Discussion

After conducting the literature review, interviews, and an examination of Skanska's working methods, an analysis was performed along with the presentation of the empirical results. This was done to integrate all the information collected in this study together. Furthermore, a discussion was held to highlight the insights and reflections that emerged during the process. It is important to note that the content presented in the discussion chapter will predominantly consist of interpretations and perceptions rather than concrete factual data.

3.5 Research Quality

This report adopts a holistic methodology, thereby facilitating its integration into a broader contextual framework. With the results of the chosen methodology, an increased understanding within the subject can be applied to companies outside of Skanska. This is despite the fact that a large part of the methods are linked to Skanska, as other companies work in similar ways and require collaboration on joint projects. Since we do not directly calculate exact figures or derive any values, we believe that the choice of our method is good and contributes to a credible report.

Individuals in various roles were interviewed to capture a comprehensive range of experiences and perspectives. This diverse group, which included 12 interviewees and interns from different work areas, provided valuable insights into the relationship between logistics and safety, which improved the overall quality of the report.

In a way, the research questions in the report may seem somewhat scattered and each could potentially stand as its own study. However, considering the relatively unexplored nature of the topic and our thorough investigation of all areas throughout the course of the work, we have ultimately concluded that they are all interconnected.

The answers obtained for each research question represent intriguing findings and therefore we have chosen to retain them.

4

Empirical Study & Analysis

In this chapter, the results of the empirical study are presented and analyzed alongside the insights from the literature review. The topics discussed include the safety culture at Skanska, with a focus on incident management, as well as a further exploration of risk-taking behaviors. Subsequently, various aspects of construction logistics, including different logistical tools and methodologies, are examined, with particular emphasis on the loading and unloading processes. Finally, the chapter concludes with an analysis of how logistics and safety intertwine, over all, and then in the context of complex building projects.

4.1 Health & Safety

The following sections will discuss the specifics of Skanska's safety culture, incident management, and risk-taking behaviors, highlighting the company's commitment to maintaining a safe working environment.

4.1.1 Safety Culture at Skanska

According to several interviewees, Skanska's safety culture is robust and significant. Interviewee 1 highlighted the company's substantial progress over the past 15-20 years, emphasizing a firm commitment to safety principles. Similarly, Interviewee 4 emphasized Skanska's strong focus on safety, mentioning annual safety week initiatives, stringent subcontractor requirements, and regular safety group meetings.

"Working unsafely is a non-question."

- Interviewee 2

Interviewee 9 echoed these sentiments, stating that safety is deeply ingrained in Skanska's work culture. They emphasized the company's well-defined rules and guidelines, strict adherence to regulations, and efforts to ensure a shared understanding between project stakeholders. Moreover, Interviewee 9 highlighted Skanska's emphasis on improved communication and coordination among stakeholders, particularly in logistics, and the allocation of resources to address safety concerns.

Interviewee 10 reinforced the notion that safety is a top priority for Skanska. They described the company's proactive approach to safety, including incident reporting

systems, extensive training, and a focus on prevention.

Interviewee 5 highlights Skanska's strong commitment to safety, emphasizing the presence of established guidelines and processes aimed at accident prevention. They underline the company's internal investigation protocols for all accidents and injuries, demonstrating a proactive approach to improving safety. However, they also acknowledge the challenge of ensuring compliance with safety regulations among all employees, recognizing that human factors may occasionally contribute to accidents despite these measures.

Overall, the responses indicate a consensus that Skanska prioritizes safety and has implemented comprehensive measures to foster a strong safety culture throughout its operations.

4.1.2 Incident Management at Skanska

The Interviewees provided various insights into Skanska's approach to safety culture. According to them, incidents are diligently reported in the company's data system, with designated investigation leaders appointed for serious events. Health and safety leaders typically supervise investigations, while minor incidents are handled by individual projects, fostering a culture of learning and risk mitigation.

Skanska demonstrates a dual approach to safety, as described by Interviewee 1. Reactive measures are implemented following major accidents, including thorough investigations and the establishment of emergency protocols. Currently, proactive efforts focus on risk identification and continuous improvement, exemplifying a comprehensive safety strategy.

Interviewee 2 observed Skanska's proactive stance towards safety, particularly in managing planning and critical operations. They emphasized the importance of coordination and prevention strategies to mitigate risks, indicating ongoing dialogue and participation in safety planning processes.

Interviewee 3 highlighted Skanska's proficiency in accident investigation, leveraging incidents to enhance workplace safety. Learning from mistakes and adjusting work routines based on investigation insights are integral parts of Skanska's safety procedures. This iterative process involves analyzing root causes and implementing preventive measures to reduce future events.

Overall, the responses suggest that Skanska prioritizes both reactive and proactive safety measures, emphasizing continuous learning and improvement to foster a robust safety culture throughout the organization.

4.1.3 Risk-taking Behaviors

The interviewees provided diverse perspectives on the factors that influence risk-taking behaviors in the workplace.

Interviewee 2 suggested that workers might become desensitized over time, perceiving a false sense of security in the absence of accidents. They also noted a tendency for workers to avoid certain risks, such as denying entry to unauthorized vehicles. These behaviors, according to Interviewee 2, could be influenced by individual factors such as personality, experience, education, and awareness of risks.

Echoing similar sentiments, Interviewee 1 discussed the concept of "home blindness," where individuals gradually become less vigilant toward the risks inherent in repetitive tasks. This phenomenon, they explained, could stem from a lack of awareness of workplace risks or a general disregard for safety regulations. Furthermore, Interviewee 1 highlighted a potential lack of respect for safety protocols among some workers, contributing to an increased propensity for risk-taking.

Interviewee 3 attributed risk-taking behaviors to deficiencies in communication, procedures, and experience. They emphasized the importance of clear guidelines and comprehensive training to mitigate such behaviors. Similarly, Interviewee 9 underscored the need for better coordination, communication, and access to relevant information to promote safer work environments. They also highlighted the potential of using artificial intelligence to improve safety practices.

Interviewees 6 and 5 pointed out stress, shortcuts, and noncompliance with established guidelines as reasons for risk-taking. Moreover, Interviewee 7 highlighted a perception among workers that risks often lead to positive outcomes, contributing to complacency and overlooking potential dangers.

Interviewee 10 emphasized the importance of awareness and adherence to safety regulations, particularly among workers who may not fully understand the consequences of their actions. They also noted a tendency for complacency and carelessness over time, leading to an increased likelihood of risk-taking.

Lastly, Interviewees 11 and 12 suggested that risk-taking behavior may stem from a lack of knowledge, experience, or control over the situation. They also noted age-related differences in safety behavior, with older workers tending to work more safely but experiencing more severe consequences in accidents.

Overall, the responses highlight the complex interplay of individual, organizational, and situational factors in influencing risk-taking behaviors in the workplace. Addressing these factors in a comprehensive way is crucial to promoting a culture of safety and mitigating risks in various work environments.

4.2 Construction Logistics

No project can do what they are supposed to do without logistics as no materials get transported anywhere and according to Interviewee 8 when you really break it down, all projects are based in coordinating different logistical flows. Still, there remains limited knowledge within the projects.

"Projects are logistics"

- Interviewee 8

The low knowledge can be one of the reasons behind the general attitude of the projects towards construction logistics described as implementation is just another cost for the projects by Interviewee 5, but they continue explaining that the logistical group can show the actual impact on the economy of the project, for example, the otherwise used man hours removed. The interviewee elaborates that a significant number of employees who have had the opportunity to engage with logisticstools express a favorable attitude towards them. However, acceptance is not universal. The interviewees argue that humans are creatures of habit and, for someone who has adhered to a particular method for three decades, embracing new methodologies can present a considerable challenge.

4.2.1 Logistics Tools

The tools provided to Skanska projects are described below, parts of the descriptions were acquired through their work procedures, Vårt sätt att arbeta (VSAA), it contains Skanska Sweden's common work methods and is Skanska Sweden's management system for leading the operations towards the best possible projects and production.

4.2.1.1 Logistics Plan

Skanska provides a logistics plan template for its projects, the purpose is stated in the template and is explained to be planning the flow of materials, machines and personnel to as well as from the project. The goal is to achieve production without disruptions, removing non-value-creating activities, decreasing damage to materials, and increasing safety. The plan is recommended to be drawn up as early as possible, but the latest stage is right before the procurement of the subcontractors. Furthermore, the plan should be updated continuously when conditions like the site layout changes. The information that Skanska requires the project to fill in includes the logistics organization, the frequency of logistics meetings, delivery details such as delivery categories, goods marking, condition of the project area, transport routes, specific requirements for transports, and rules for the drivers. In the case of a TPL being utilized for the material handling on-site information regarding how subcontractors can make use of this service is provided within the logistics plan as well.

Implementing a logistics plan in an early phase helps projects with the costs of the

projects as well according to Interviewee 9, the reason behind it is that the plan forces the involved people to think further on how the logistics will work on site and find possible problems in an early stage. The costs related to the stage the problems are addressed in is illustrated in figure 2.2. The identification becomes more important the less space and more neighbors the project has according to the interviewee, one example brought up was a project close to a school making deliveries during certain times impossible and therefore the rules in the logistics plan stated certain times when deliveries could arrive to site. A further advantage is that the procurement of subcontractors becomes easier if the project already has the rules and requirements for the logistics and clearly states them. But the interviewee presses on the fact that they have to follow the rules themselves as well to make sure that the site stays clean and operates in an optimal way.

Interviewee 5 states a further benefit with implementing a logistics plan being that the project can have clear rules regarding the latest time a delivery can show up, it is explained that a problem arises when deliveries arrive a couple minutes before the end of the day when personnel has already started leaving, causing unloading to be understaffed. However, according to Interviewee 5 the implementation of the logistics plan is rarely done in the correct way, the majority of the projects do not update the plan during the project rendering, making the plan less effective than it could be.
Interviewee 3 explains that their current project has a logistics engineer who has responsibility for the logistics plan as well as other logistical responsibilities. However, since the workload otherwise is the other managers' responsibility, this resource is hard to include in smaller projects, but the interviewee thinks that it should be included in all bigger projects as it reduces the often high workload of the managers on site. Interviewee 8 adds that the logistics group has a hard time following up the usage of the logistics plan as they play no part in implementing it in the projects, unlike other tools where they have a bigger supporting role.

When comparing Skanska's logistics plan with the information gathered from the literature review there is a lot of similarities, one of them is the recommendation of the implementation in an early stage of the project as well as updating it during the project when needed to achieve the best results. The recommendation of a logistics manager is included in the literature as well, and according to the interviews, it is implemented in certain projects. The goals align as well between Skanska and the literature as one of the main points are that the non-value adding activities should be reduced and that the flow of materials are controlled to a higher degree. From the interviews the general perception has been that the more well planned a site is, the safer is it as the management can easier spot issues that might occur, and this would be an additional benefit of proper implementation of a logistics plan in the projects. Where Skanska's logistics plan differs is that some of the recommended tools and guidelines in Table 2.1 are not included such as an analysis of the technological alternatives, the reasoning behind this is unclear, as Skanska provides tools for the logistics both in house and through framework agreements.

4.2.1.2 Delivery Calendar

Skanska has developed their own delivery calendar, and according to the Interviewee's there is a requirement on projects with a cost of 50 million SEK or more to implement it. The calendar works by Skanska's own personnel and subcontractor booking a delivery in the program, in this booking there is the possibility of adding place of entry, unloading area, as well as unloading resource. The current work disposition plan should be added to the program as well to ensure that the people planning deliveries are up-to-date with current conditions.

Interviewee 9 presses the fact that the calendar is not only a planning tool but a tool that should be used for following up deliveries, if a project does not use the calendar, its hard to notice deviations in the deliveries as the planning is generally not as detailed. Furthermore, the interviewee explains that the deviations are tied to the safety aspects and that if the deliveries are planned, the deviation becomes a risk indicator. The day-to-day planning of the logistics becomes an easier task according to Interviewee 10 as the person responsible for loading and unloading can be prepared with the appropriate resources needed, an example brought up was that a busy day might need two or three people allocated while some days there might only have one delivery, freeing up those resources to other tasks.

Interviewee 8 presents an issue with the delivery calendar, all project over 50 million should use it, but the reality does not always look like this because of the fact that there is a lack of consequence if it is not used. Additionally, the calendar adds working hours for the project when it comes to keeping track of the deliveries and confirming that there are not to many booked as well as making sure that the site disposition is as it is presented in the program. According to Interviewee 5 the usage of the delivery calendar is around 90% but only around 50 to 60% of these are used in the correct manner.

Interviewee 11 is of the opinion that the delivery calendar is a tool that does not fit all projects. From the experience gained from previous projects aimed towards commercial use where the person has been involved, the value of implementing the calendar has been minimal on projects where the logistics have been simple with few deliveries as well as no site obstacles a whiteboard can have the same effectively. However, the interviewee states that the current project would not be possible to complete without the usage of the calendar as the site is very cramped as well as limited space for unloading. Interviewee 7 has experience with both using a whiteboard and the delivery calendar and thinks the reason behind the implementation is largely down to the size of the project, but not necessarily because of the money, rather the space available on site as well as the amount of deliveries that the project will receive.

The descriptions of Skanskas delivery calendar is very similar to the example of a good delivery plan system brought up in the literature review, including booking of slots, resources available and being able to warn the users of conflicts in the schedules. However, the recommendation of enforcing the rules related to the calendar is

where the literature and empirical results differ, with a majority having the problem-solving mentality regardless of a delivery being booked or not. The literature also recommends the implementation of a logistics manager to ensure that the calendar is used in the proper way as well as to enforce the rules. From the interviewees who had experience working with a logistical manager, the opinion was positive because of the workload being transferred but the enforcement did not necessarily happen.

4.2.1.3 Construction Consolidation Centre

Skanska has a framework agreement with a company for their CCC's where projects can reach out to the logistics group for support regarding the economic value as well as implementation if it proves beneficial. The materials are delivered to the CCC and then the materials are consolidated in the transports heading to the site. The deliveries are planned in a delivery plan that is connected to the productions time plan to ensure that the materials that are required are delivered on time. There is no single solution for all projects, but the service is available for all types of construction, and it is vital to ensure that the solution is customized to the needs of the project in question.

According to Interviewee 8 CCC's are used in somewhere around 9/10 housing projects in the regions they are involved in but less when it comes to commercial building projects. One reason behind this, presented during the interview, was the way that housing works with takt planning, which makes it easier to implement CCC as well. The implementation numbers seem to vary between the regions as Interviewee 5, who is in a different region than Interviewee 8, estimates that around 45 to 50% of projects that utilize CCC's in the regions that they are active within. Interviewee 3 has been involved in both projects that utilize a CCC and those that do not, the situations that were improved the most according to them were the materials that were going into apartments such as flooring and kitchen furniture. From a project that did not use a CCC the deliveries were described as more chaotic.

> ***"Every delivery just arrived, we had decided certain dates but everything just arrived the same day"***
>
> ***- Interviewee 3***

However, the interviewee mentions that some of the production managers have different opinions of the usage of CCC's. An example from a previous project was that a production manager stated that the cost of using a CCC was too high, while the interviewee thinks that the time otherwise needed from personnel on site costs money as well, but just is not as visible. Interviewee 6 shares the notion that the costs of a CCC being more visible but adds that the transports themselves being fuller when they arrive can save the project time as well. Interviewee 4 states that in communication with projects, they can communicate the benefits such as the fact that the deliveries arrive when it is planned but that in the end it is up to the project to decide if they want to use it or not. Another benefit mentioned by Interviewee 4 is that the project has more control over the transports to the site. One example brought up was the possibility of dictating what type of vehicle that transports the

materials, this makes it possible to request a truck with a crane in the case of no resources on site being available. From the experience of Interviewee 5 the managers that have used a CCC solution almost always want to use them again but that the initial implementation is where the managers require a bit of persuasion.

4.2.1.4 Third Party Logistics

Projects within Skanska have the possibility of implementing material handling on site through the use of subcontractors, this can be done both within the ordinary work hours as well as after work hours. The benefits are described as freeing up time for blue collared workers as well as reducing the risk of material damage.

According to Interviewee 5 the usage of TPL's is around 20% in the projects that they are involved in, the project that uses TPL's often takes the decision of implementing it again depending on the previous experiences but the logistics group has a calculation tool that they can use to support the projects if they feel as they require a more in depth investigation on the financial side. Interviewee 10 mentioned the fact that by using a company that has trained personnel when it comes to logistics often leads to better results, especially when it comes to the more difficult materials if you compare to the other workers on site. However, Interviewee 11 thinks that implementation of TPL material handling is situational to projects, their current project requires material TPL's as there is not enough space on site to store anything. But the experiences in previous projects were not just positive, when the Interviewee had a commercial project and utilized TPL's for the material handling of gypsum boards it caused more problems than it solved as the materials were carried in in large amounts one to two times a week, no matter how well planned the placement of the material was carried out the materials obstructed construction to some extent. This clashes somewhat with the literature, as the results that the literature presented was a reduction in the costs of gypsum, this might be down to the fact that the literature was based on housing rather than commercial but might be because of project specific limitations like the material amounts delivered or the storage possibilities.

According to Interviewee 8 the usage of external material handlers depends a lot on the economy, when the economy is bad, the construction companies tend to want to use their own personnel in a bid to not have employees without work. Interviewee 11 has a similar opinion and says that a project cannot bring in external personnel for the logistics if there are employees in the region that are without work as there is a will to protect the people within the organization and not let them go because of shortage of work. Interviewee 4 mentions that the Skanska has framework agreement for companies that should be used when it comes to third party actors but from his experience is that depending on where you are located the projects decide to use local firms. The benefits of using it according to the interviewee are that the skilled workers have more time to do what they are experts at and speed up general material handling on site.

From the study in the literature review the implementation of a TPL has the positive

effect of reducing material costs, but from the interviews it seems to be somewhat project dependent. This can be based on many things like site layout, the amount of materials as well as the attitude towards it from the project management. The literature mentions that the TPL providers themselves state that the implementation is backed with planning and more effective structure. Takt planning provides the planning to a further degree, but to ensure the implementation success, the project should look over their structure in order to achieve the highest possible effects.

4.2.2 Loading & Unloading

To improve safety during loading and unloading, Skanska has defined the roles of those involved in the process, see Figure 4.1. The purpose is to clarify the various roles and tasks outlined in the procedures. In many projects, individuals may assume multiple roles throughout the duration of the project.

Figure 4.1: An overview of the roles in relation to loading and unloading (illustration provided by Skanska)

Purchaser: Effective workplace safety and workflow during delivery of goods depend on proactive communication and preparation. Key practices include classifying goods early in the procurement process, clearly providing contact details in shipping documents, and ensuring that drivers are informed of specific safety protocols and arrival procedures. Risk assessments should identify and communicate any special handling requirements to suppliers or subcontractors. It is also vital to keep all stakeholders in the project informed of the delivery agreements and conditions, including the specifics of the time, location, and unloading protocols. Ensuring the availability of appropriate unloading equipment and properly securing the goods are crucial to safe and efficient handling at the delivery site. Interviewee 8 would like to see more use of their digital purchasing system as most current purchases

are handled through email and phone contact. The main benefit would be that the purchases can be automatically added to a projects delivery calendar instead of manually adding the deliveries. However, the interviewee notes that the purchasing system would have to be further developed in order to handle the bigger materials, as it is currently focused on consumables.

Delivery Coordinator: The delivery coordinator plays a crucial role in ensuring the safety and efficiency of the delivery operations. Each day begins with a briefing to prepare the team for the coming deliveries. The coordinator assesses unexpected delivery situations for safety, directs drivers to appropriate areas to maintain order, and confirms safety protocols before unloading begins. Collaboration with the recipient and the driver of the goods includes a visual safety assessment of the unloading area. The coordinator also engages with the drivers to understand their role in the loading process and mitigate the risks associated with premature cargo restraint release. By maintaining clear communication and adhering to safety protocols, the delivery coordinator ensures smooth and secure delivery operations. The delivery calendar can increase the effectiveness of the delivery coordinator according to Interviewee 7, during the morning meetings the day's deliveries get mentioned but with the calendar the coordination has increased as future deliveries are shown and taken into account when booking new deliveries. In Interviewee 3's current project the coordination is done by a on-site logistician that has the responsibility of the delivery calendar and coordinates the subcontractors deliveries as well, for them it has worked well with less stress regarding deliveries being put on the management as they only provide the logistician with the right info and knowing that it will be taken care of.

Freight Receiver: In the unloading process, the delivery coordinator, the goods recipient and the driver collaborate to perform a visual assessment to ensure safety before transferring responsibility to the cargo handler. The goods receiving company, which is primarily responsible for overseeing this process, ensures compliance to safety protocols and efficient operation. Strict compliance with any established lift plan is vital to mitigate risks and maintain safety. If safety concerns arise due to identified hazards, unloading is immediately stopped to prioritize the safety of personnel and property. According to Interviewee 2 the supervisor often gets the responsibility of being the freight handler but that there is often little time to actually do this, the supervisor has to appoint another person to do this to make sure that the deliveries are compliant with the requirements. The Interviewee describes that this can sometimes become a problem when, for example, a subcontractor is appointed for their own deliveries and has not been informed about the requirements that Skanska has on deliveries. Interviewee 3 explains that the driver of the telescopic handler is responsible for freight reception in their current project and that this solution in combination with collaboration with the logistician they have on site has been a very good solution as it removes the time spent running back and forward for the supervisors.

Driver: During loading, drivers must secure the cargo for safe transport, with the

sole responsibility of them. Upon arrival, they inform the coordinator and begin unloading. Drivers should know the safety protocols. Collaboration between driver, coordinator, and recipient ensures safe unloading. Drivers must wait for approval before unloading, prioritizing safety throughout. However, this is not always the case, Interviewee 1 explains that the most recent accidents have been down to drivers taking initiatives without the receivers not being ready. The most important factor in order to reduce these kind of incidents according to the interviewee is through human contact during the freight reception and not much is required, a quick instruction on where to stop or if needed where to wait suffices most times. The safety protocols are not always followed by the chauffeurs either according to Interviewee 4, at some of the projects a manager will have to tell them to put on the appropriate PPE when leaving the truck.

Lifting Coordinator: Before starting lifting operations, thorough preparation is crucial for safety and efficiency. This includes obtaining a lift inventory from subcontractors, developing detailed lift plans for all operations, and ensuring the availability of the necessary equipment and trained personnel. Safety measures such as the use of guide ropes and the availability of the necessary documentation and certifications are mandatory. A rescue plan must be in place for crane operations. Regular meetings and daily briefings are conducted to keep all personnel informed and aligned. Continuous monitoring, random checks, and maintenance of lifting equipment ensure compliance with safety standards and prevent potential hazards. Interviewee 1 noted that having a specific lift meeting once a week would be a valuable addition to increase the communication and the lift coordinator being more involved in early stages to question certain aspects in order to facilitate discussion around critical activities.

Freight Handler: To ensure safe lifting operations, thorough checks are carried out on the lifting equipment prior to use, ensuring that it is free of defects. The loads are securely attached following safety protocols to prevent instability. Proper storage of equipment is vital to prevent damage. Disposable slings are used for specific loads and are disposed of afterward. Effective communication, especially for distant signalmen, is ensured through radio communication. Guide ropes are used to control suspended loads unless approved otherwise. These practices prioritize safety and efficiency in lifting operations. Interviewee 1 thinks that many employees have the wrong perception of the reasons why the lifting equipment needs to be registered and checked regularly, and might think that its just to make sure that the paper exists when, in reality, it is for their own safety.

Supervisor Specified on the Lift Plan: Before any lifting operation takes place, planning is essential to ensure safety and efficiency. The process begins with careful planning, where the lift is mapped out and a detailed lift plan is created. This plan outlines every aspect of the lift, from the equipment needed to the steps involved in the operation. Once the lift plan is finalized, it is shared with the lift coordinator. This ensures that everyone involved in the operation is aware of the plan and understands their role in its execution. Throughout the lifting process, it is crucial to

adhere to the lift plan with great care. This means following the steps outlined in the plan and using the designated equipment as specified. By ensuring that lifts are run according to the lift plan, minimize the risk of accidents, and ensure that operations run smoothly and efficiently. The lifting plan got some negative feedback from the interviews however, Interviewee 11 pointed out that the lifting plans are excellent for advanced lifts that require their own lift plan but less effective when it comes to simple often repeating lifts. From their perspective the general lift plans for materials like rebar becomes somewhat redundant as the plan is not updated with the current conditions like weather but at the same time it would not be sustainable to do new plans for all lifts as they happen up to 10-15 times per hour. The proposed solution of making the lifting safer is the standardization of loading coupling as the current practises are described as only based on each persons knowledge and the lifts they have previously done them themselves. And the interviewee sees this as a solution that does not remove lifting plans but rather complements the lifting plans in the more simple lifts to make sure that no unnecessary accidents occurs.

Signal Man: During lifting operations, the signalman plays a critical role in ensuring safety by maintaining constant vigilance and facilitating smooth operations through effective communication with the crane operator, using hand signals, verbal cues or radio for distances greater than 20 meters. Clear instructions and protocols for control transfer with multiple signalmen are essential to ensure safe load movement, minimize risks, and maintain operational safety. The importance of communication during lifting operations was highlighted by Interviewee 3 as they recently had an accident on site due to lack of communication during the coupling process. In this case, it was the communication regarding how to prepare a lift in the correct way that was found to be lacking, and considering that crane lifts are one of the most dangerous moments on site according to the interviewee makes it more important that they are adequate. Furthermore, the accident occurred while lifting materials that they were not used to, and this requires even more communication than a lift that the personnel are used to according to the interviewee.

Crane Operator/Machine Operator: In crane and machine operations, it is crucial to identify and understand the roles of riggers and signalmen to ensure effective coordination and communication. Regular joint meetings with the lift coordinator, riggers, and signalmen are vital to discuss potential hazards and establish a unified lift plan. Adherence to the designated signalman's instructions is mandatory, except in emergencies where operators must respond to any stop signal immediately. For increased safety, especially when the distance exceeds 20 meters, communication should be maintained by radio to prevent misunderstandings and reduce accidents. Interviewee 3 mentions that when hiring new subcontractors the communication with the crane operator becomes a problem as their not used to the routines and might not even have the correct education initially, this requires a lot of work to sort out but is required to be able to lift in a safe way.

Issues with responsibility allocation: Issues can arise if one of the employees responsible for a certain role is on vacation or absent based on other reasons as the responsibility needs to be handed over to another part that might not have enough time available to complete the tasks correctly according to Interviewee 3, one example brought up was meeting the transports at the gate might not always happen. According to Interviewee 2 some supervisors that have the responsibility of greeting the deliveries and inspecting the way that they are loaded think that it is somewhat optional and not a requirement leading to some transport not being checked, the interviewee has a understanding for that the time to do it does not always exist but presses the fact that if that is the case the activity needs to be delegated.

4.3 Logistic & Safety

To analyze which parts of the logistics are most connected to security, we will utilize the framework found in Figure 2.1. Furthermore, limitations have been acknowledged, and thus we have chosen to focus solely on all branches except for the society, work group, contractor, and project management. To further analyze, we will highlight the sub-factors that, through interviews, have appeared to be the main factors when it comes to on-site logistics, see Figure 4.2.

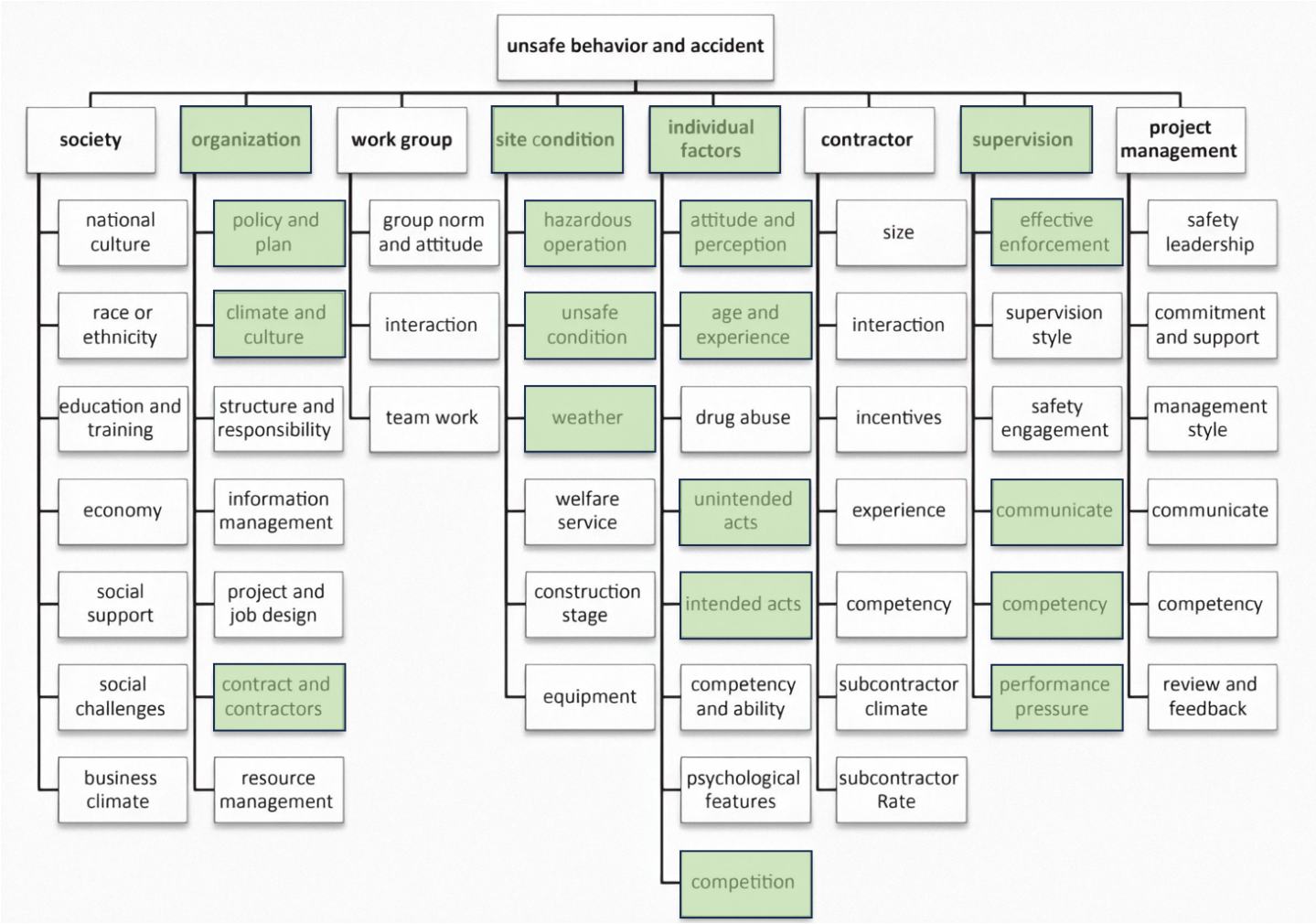

Figure 4.2: Conceptual framework for factors influencing unsafe behaviors and accidents on construction sites (Khosravi et al., 2014)

4.3.1 Organization

In the literature, it is clear that safety **climate** constitutes a significant part of safety **culture**, and it is crucial to distinguish between them. According to our interviews, all respondents emphasize that the safety climate at Skanska is particularly good and that great importance is placed on safety aspects during loading and unloading. To foster a robust safety culture, Interviewee 1 stresses the importance of an environment where errors are not viewed as grounds for punishment but rather as opportunities for learning, by delving into the root causes of mistakes. In addition, they elaborate that Skanska conducts an annual survey among all employees to gauge the workplace safety climate. This survey includes inquiries about satisfaction levels, perceptions of the work environment, and, for example, experiences with stress.

Interviewee 3 shares the notion that they and their colleagues strive to be open and attentive towards one another. It is crucial for them to listen to each other's opinions

and feelings, even regarding sensitive topics. At the same time, they emphasize that safety always comes first. Everyone must be vigilant and aware of their own safety and that of each other. It is part of their responsibility towards one another. Moreover, they stress that there is no pressure that prevents anyone from speaking up if needed.

"We work safely or not at all"

- Skanska

Furthermore, it is common for construction industry workplaces, as described, to be dynamic and require organizations to rely heavily on the expertise and skills of their personnel, which fosters a culture of participation and empowerment in decision-making processes. This means that on-site logistics planning is challenging and many interviewees stress that unexpected events during the workday are common and require quick on-site solutions. For example, Interviewee 7, mentions that delays in deliveries can cause stress and that unexpected deliveries are one of the most critical moments for accidents and incidents within the logistics chain. To handle this, careful **policies and plans** are required so that during stressful situations, it is clear which work methods should be applied to ensure safety as effectively as possible. This is something that Skanska integrates, among other things, through its motto "We work safely or not at all", Vsaa and through their lifting plans.

In addition, fostering good contact and communication among all individuals working on the construction site is essential. This can be influenced by the organization through **contractual** agreements and the selection of **contractors**. Interviewee 3 discusses the challenges they face in influencing the culture of subcontractors. They note that this difficulty is compounded by the presence of foreign workers who may hesitate to voice concerns due to their trust in established plans. It is observed that these workers tend to adhere strictly to the instructions, reflecting their cultural background. This cultural aspect presents a significant hurdle, particularly when working with new subcontractors unfamiliar with Skanska's operations. Interviewee 3 emphasizes the importance of consistency in subcontractor selection, highlighting the benefits of working with trusted partners who understand and align with established procedures. However, due to economic pressures, there is a need to explore new subcontractors, introducing the complexity of integrating them into existing workflows. They stress the time-consuming process of building relationships and trust with new partners, particularly in the context of safety protocols and procedures. Interviewee 3 mentions the necessity of reeducating new subcontractors on safety expectations, especially regarding crane operations and lift procedures. This involves ensuring that subcontractors have the necessary training and comply with contractual obligations. Despite the challenges, Interviewee 3 acknowledges the market-driven nature of subcontractor selection, underscoring the need for flexibility in navigating these dynamics.

Interviewer 2 also emphasizes the advantage of safety when having the same subcontractors on site, as it allows for building relationships and embedding attitudes and

cultures. It is not always possible to procure the subcontractors of choice. Sometimes, one must opt for those with the best price, which may require more time and money spent on introduction and safety work. Sometimes, clients demand additional focus on safety, such as more comprehensive safety introductions. However, as time is money, striking a balance between safety needs and the project's financial demands poses a challenge.

Furthermore, Interviewer 2 identifies a need for labor that is not always available in Sweden. This can create challenges such as language barriers, which can pose risks during tasks such as loading and unloading when communication between workers and drivers is essential. In addition, the challenges of different values and safety cultures are emphasized, such as the various perceptions of the use of PPE regarding the frequency, timing, and condition requirements.

4.3.2 Site Condition

The conditions on site vary significantly, often leading to **unsafe conditions** due to their unpredictability. Interviewee 10 mentioned that the loading and unloading areas could be improved compared to current standards of the use of gravel covered areas. From their experience, most areas utilized for loading and unloading will at some point be paved, and the proposal made by the interviewee was to pave the area in an early stage to ensure the strength of the ground. Furthermore, the possibility of using hand-operated pallet pullers on asphalted ground for smaller deliveries was brought up and would decrease pressure on other unloading resources when needed. The reduction in resource allocation could in certain cases decrease the amount of machines needed on site and therefore reduce the money spent on unloading while increasing the safety. This solution would be a step in the direction of more effective resource management, but implementation of programs like the ones described in the literature review that can coordinate resources between different projects could cause further benefit in combination with this, as most projects might need more resources during certain times. Furthermore, an asphalted unloading area would standardize the unloading to a further extent, and this can have safety benefits as well as found from the investigation regarding the unloading docks and reduce the number of accidents.

When it comes to construction sites there are requirements to have restrictions surrounding the site to ensure that no third party or unauthorized personnel enters according to Interviewee 9. To ensure compliance, regulations are established concerning who is authorized to open the gate for deliveries. This becomes even more crucial when the site is shared between multiple actors. The interviewee thinks that logistical tools, such as the delivery calendar, can facilitate greater control over this factor to ensure that the site is safer. But even authorized personnel can cause problems, as Interviewee 5 states that the chauffeur is the most exposed party and that the problem stems from the fact that the other people on site know the routines while the driver might be on site for the first time.

From a logistics perspective, the most **hazardous operations**, according to Interviewee 4 and 5, occur during material handling, both on site and during loading or unloading. The interviewee emphasizes that the site conditions vary, unlike a factory or terminal, due to changing weather, ground stability, and different chauffeurs familiar with the routines and rules. Another factor mentioned related to loading or unloading is the lack of barriers around designated loading areas to ensure that unauthorized personnel remain at a safe distance. Interviewee 6 thinks that the separation of vehicles and people is the most critical aspect when it comes to safety on site, but that the planning of logistics can be a difference maker. Logistics planning can facilitate better loading or unloading areas, the correct way to place barriers, and ensuring that the area is large enough to ensure safe unloading. Routes for the trucks planned movement on site are a part of the information that is included in Skanska's logistics plan template, according to the theory, this leads to shorter turnaround times and actual planned routes. This should lead to fewer accidents both based on less time on site for vehicles as well as more separation of people and traffic through thought-out routes.

Planning can also serve as an indicator for deviations according to Interviewee 9, their explanation is that without having the activities planned, there is no way of knowing if there is a deviation as there was no consensus on how it was supposed to go, while if they are planned, it is easily identifiable. The interviewee feels like there is a general lack of resources dedicated to planning within logistics and that this could be one of the reasons that the industry has not developed further within the subject. But planning does not guarantee the outcome, and according to Interviewee 7 the most dangerous situation is when deliveries arrive outside of the agreed time. The reasoning behind this was that it can cause faulty initiatives to try and get the materials to the right place, as well as stress.

Additionally, according to Interviewee 8 there exists a problem when it comes to material storage on site. Storage on site causes personnel to move around on site in often unplanned ways and increases the risk of both damage to the materials and personal injuries. This can be reduced by using CCC facilities to a larger extent, moving the storage to a CCC would reduce the damages to both materials and personnel as the materials would only arrive when needed. However, from the theory one limitation is presented, and that is that the CCC's are more focused on smaller size materials and not prefabricated concrete elements, and depending on the type of materials stored on site this can cause a CCC to not be a viable option.

The safety on construction sites is affected by factors that cannot be planned, such as **weather**. Interviewee 2 discussed an incident where a plank that was supposed to be a fall protection equipment fell because of the wind speed being high, the underlying problem was that the plank was not screwed in, but rather nailed by a worker. This was something that had not failed from his previous experiences, but according to the interviewee, this shows how people assess risks by their experiences and how volatile a construction site can be. But weather can also affect logistics

specifically according to Interviewee 3, explaining how the unloading process can be significantly impacted by snow, rain, or wind. The harmful effect described was when the materials take more time to unload than expected, and this in turn can cause problems with the delivery schedule if there are continuously arriving trucks planned, leading to more stressful situations as well as to potential risk taking. When it comes to lifting operations with cranes the wind becomes a vital aspect for ensuring safety, Interviewee 11 explained that for reoccurring simple lifts there is generally only one lifting plan with stated maximum wind speed that if exceeded stops all lifts. From the interview certain problems with the lifting plan were explained, such as the wind or temperatures, as these change from day to day and the single lifting plan for simple lifts, and the interviewee's current project has therefore decided to compile the rules in a routine list instead that is easier to communicate and understand for all parties.

4.3.3 Individual Factors

Interviewee 10 explains that workers on site are usually very solution-oriented and try to handle the problems that arise. However, it can sometimes be frustrating when solutions are only temporary and do not address the root cause of the problem. There is also a discussion about how the urgency to move forward sometimes leads to exceptions being made, which ultimately create more problems and risks. Sometimes, it may be better to be more consistent in handling such situations. For example, when it comes to deliveries from suppliers, a situation is described in which deliveries often arrive earlier than expected, which can cause problems for planning. Despite these challenges, those on site typically try to find quick solutions or improvise alternative plans to deal with the problems, especially when there is some form of **competition** between companies and performance is needed.

"To ensure a safe workplace, we need to acknowledge that humans will make mistakes and we need to build systems where the human factor doesn't affect if it's safe or not."

- Interviewee 12

Interviewee 7 expresses the view that a significant portion of individuals, sharing a similar mindset to their own, tend to engage in risky behaviors and seek shortcuts in their daily activities, despite being aware of the potential hazards involved. This inclination toward risk-taking behavior is often justified by the observation that these actions frequently lead to positive outcomes, reinforcing a sense of satisfaction with the associated dangers. This phenomenon highlights the complex interplay between perceived benefits and acknowledged risks within individuals' decision-making processes. As the literature review shows, studies indicate that inappropriate actions, such as unsafe practices, improper use or non-use of provided personal protective equipment, and taking shortcuts, are immediate causes of construction accidents. In addition, it underscores the importance of examining the underlying motivations and cognitive biases that drive these behaviors.

"It might go well nine out of ten times, but the tenth time it might not go so well"

- Interviewee 7

Interviewee 7 states that people often take risks in the construction industry because they assume that everything will go well. When they take risks and things usually go well, it can become dangerous because they may start to believe that things always go well. This can lead to overlooked risks that can lead to injury. In addition, they believe that the perception that one can save time is a factor in taking risks at work, even though they know that it is not the correct course of action and can lead to risks being taken.

Interviewee 6 suggests that stress and a desire for shortcuts can lead people to engage in intentional acts of risk-taking on construction sites. These **intended acts**, fueled by pressure or urgency, pose significant hazards, increasing the likelihood of accidents and injuries. Despite the critical importance of a meticulously planned and safe unloading process, the speaker underscores the need to mitigate these potential incidents.
Similarly, according to Interviewee 4, intentional acts of risk-taking in the workplace often stem from factors like lack of knowledge or attention, especially under pressure to meet deadlines or deliver products. These intended acts, despite being aware of potential consequences, prioritize goals over safety, increasing the risk of accidents and injuries.

Unintended acts in the workplace often stem from various factors that may not be immediately apparent. Interviewee 12 highlights the influence of habituation, where individuals become accustomed to performing tasks in a certain way, potentially leading to a loss of awareness of potential dangers. This emphasizes the importance of establishing routines that account for human error and mitigate the risks associated with repetitive tasks. Similarly, Interviewee 11 emphasizes that risks are often taken unintentionally due to factors such as lack of knowledge, experience, or awareness of risks. This lack of understanding underscores the need for comprehensive training and education to promote safety in the workplace and ensure that individuals have the necessary skills and awareness to recognize and mitigate risks effectively. Interviewee 10 further elaborates on the unintended risks that stem from a lack of awareness of risks and consequences. Individuals may unknowingly misunderstand the dangers associated with not using protective equipment or following safety rules, leading to risky behavior. Over time, complacency may also develop, increasing the likelihood of taking risks. Heightening awareness of risks and consequences is crucial to addressing these behaviors and promoting a safer work environment. Building on this, Interviewee 5 emphasizes the human factor as a significant contributor to workplace accidents, citing carelessness and unpredictable factors such as having a bad day. Despite established routines and procedures, unforeseen circumstances may lead to lapses in judgment, resulting in unintended risks. Recognizing the inevitability of human error, it becomes imperative to integrate strategies, as suggested by Interviewee 12, that acknowledge and address these inherent risks. Additionally,

Interviewee 1 highlights the challenge of recognizing risks inherent in one's work, particularly in hazardous tasks. Even with established safety protocols, individuals may become blind to potential dangers over time. This oversight underscores the importance of regularly reassessing safety procedures and protocols to ensure ongoing protection for workers and mitigate the risks associated with workplace tasks.

Interviewee 12 explains that they cannot definitively answer the question about habit. They have also encountered this pattern in their previous interviews, but are not entirely sure of the cause. From previous studies, they have observed that people with longer professional **experience**, and therefore older in **age**, tend to work more safely. However, when accidents occur, they tend to be more severe, especially because the body does not recover as easily as when one is younger. For example, a misstep could result in extended sick leave. In contrast, younger people often work less safely but are more resilient to minor mishaps. Therefore, both extensive professional experience and the age bracket probably play a role in this dynamic.

Interviewee 3 also emphasizes the importance of experience, pointing out that it is crucial to establish one's own routines when working with logistics. Although one may be highly engaged, as a newer and less experienced worker, it is necessary to accumulate experience to handle all situations and to recognize risks, such as during unloading operations. Therefore, Interviewee 3 sees a correlation between the risk of accidents and experience.

Interviewee 1 regards **attitude** towards safety as a crucial aspect of a safe work environment. They mention the importance of fostering a positive attitude towards safety culture and being aware of risks, but lament the low emphasis on training. However, they stress the importance of making people understand that they are responsible for their own safety if something goes wrong, not those in charge. Interviewee 2 explains that they typically aim to elevate attitudes by emphasizing how they want tasks to be done, rather than focusing on what not to do.

4.3.4 Supervision

Communication is a vital part of the logistics on site according to Interviewee 3, from their experience it does not matter the amount of paperwork done leading up to the activity unless the communication is handled in the right way. One example brought up was an incident where a crane was lifting trusses, everything was coupled right and double checked but at some point one of the trusses wasn't connected to the hook because of a lack of communication between the people doing the coupling and the crane driver.

"If we don't have communication it is not safe"
- Interviewee 3

Additionally, Interviewee 2 shares a similar view on communication when it comes to on-site logistics coupled with safety and thinks that sometimes the project oversimplifies the communication on-site. One example brought up was that the crane activities rely on the morning meetings, this might not be enough, and the interviewee proposed to add specific crane meetings to bring possible safety issues to light as these do not always get presented at the more general meetings.

The importance of communication regarding safety within loading and unloading is included in the report from Skanska Teknik and was one of the most popular critical aspects of safety on site according to the respondents. This suggests that a larger focus on the way communication is handled in regards to logistics could prove beneficial for the safety on site. But one aspect within loading and unloading that can easily get overlooked is the fact that the chauffeur is often someone completely unknown by the project according to Interviewee 9, they continue by explaining that even though everything has been done by the book, the chauffeur has not taken part of the information produced. The interviewee states that the last three accidents that have led to a death have had a chauffeur involved and that they are currently not included in their own safe work methods. The change he proposes is that the individual receiving the transport communicates the plans with the driver to make sure that he knows where to go and what to do. Interviewee 9 points out that communication is not just to counteract incidents, it is important to make sure that things go as planned as well. Communication about how the logistics solution is planned with subcontractors is also vital to achieve the expected results according to Interviewee 9, but in order to communicate the plan, it must exist and be enforced.

However, **effective enforcement** is harder than one might think, Interviewee 10 brings up the example that the lack of stopping unplanned deliveries are not based in not having the power to do so but rather down to the problem solving mindset that exists within the industry. However, they think that if the projects started stopping transports to a larger degree, the delivery companies would start to follow the times almost immediately as the consequences would hit them hard. Continuing on the issues with enforcement, interviewee 4 mentions that within Skanska there are requirements on the projects to have a logistics calendar, but not how it is supposed to be used. Their opinion is that if the requirements were stricter in how the implementation was to be done, the results would be more beneficial. From the theory there is a focus on the enforcement regarding the delivery plan system as a booked time slot that does not get used is a missed opportunity for another delivery, as well as the fact that unbooked deliveries need to be turned away. The manager responsible for this therefore needs to be ready to take conflicts and not give in. From the interviews the general notion was that employees had the possibility to turn away deliveries but that the issue stemmed more in the problem solving mindset mentioned earlier.

Interviewee 10 shares that Skanska as a company has initiatives that try to increase the **competency** and improve safety culture and knowledge by dedicating one week a year to safety initiatives such as spreading good examples. From a safety perspec-

tive, the larger companies generally have better knowledge when it comes to working environment and actually have the resources to dedicate to specific questions compared to smaller companies according to Interviewee 12. From their research, they have found that one of the bigger problems within construction is the long chains of subcontractors within projects, and their own opinion is that a simpler organization with more of the personnel of the project being within the same organization might bring benefits as more people can benefit from the resources that the larger company can provide. But with large companies having limited blue-collar resources, one way to improve safety and logistics at the same time could be implementing supplier collaboration to a greater degree. This could benefit both the main contractor that can teach the subcontractors their routines and rules to a further degree while the subcontractor can benefit from expanding their knowledge of how a certain company works with safety and making the appropriate modifications to comply with them. However, the literature states that the main factor keeping this from happening is the top management commitment and some changes might need to be made in the way that the subcontractors are procured. The way they are procured currently according to Interviewee 3 is that often there is no consideration to the previous relations but rather the lowest price. This is a more recent problem according to the interviewee, as the economy has become more restrictive and their opinion is that they have been somewhat spoiled for a period. But looking forward, their opinion is that reeducating new subcontractors will become a big challenge and it will take time before the new companies get to know their routines and the project management can create new relationships and trust each other.

There is a lack of knowledge when it comes to construction logistics according to Interviewee 8 but their opinion is that the trend is heading upward, with some training happening, and younger people from universities who have more general knowledge on how logistics can affect production times and productivity. However, the interviewee still thinks that there are a lot of people who lack the needed knowledge and that many younger people are thrown into logistical roles without real-life experience.

One of the reasons that the knowledge has not developed further might be because of the general lack of **performance pressure** on the logistics, Interviewee 8 explains that as long as the project goes well otherwise and does not implement any of the logistical tools there are no consequences. The fact that there exists no central logistics strategy and that it is up to each project to choose what they want to use and not is presented as having both positives and negatives, but the interviewee notes that more recently the logistics calendar has become part of the central guidelines.

4.4 Complex Building

When it comes to complex projects, the logisticssolution often consists of the person who is the informal leader of the production managers according to Interviewee 8, from their experience the project that contains both parts of the organizations and the result has become that they work in two separate ways when it comes to

optimizing the supply chain. The interviewee noted that the housing side more often than the commercial side wants to use CCC services and that the commercial side often argues that the space available will serve as storage on site. However, organizations still need to be in agreement when it comes to site disposition plans, the way deliveries will travel on and enter the site, as well as the placement and usage of elevators. From the literature, the proposition regarding having a TPL that has the overall responsibility of the logistics on site could have the effect of reducing strains between the organizations when problems arise within the logistics as the governing party is the TPL. Furthermore, the benefits already mentioned regarding CCC's as well as material handling could be utilized.

One reason behind why housing project generally utilize tools like CCC's more than commercial might be the utilization of takt planning according to Interviewee 5 and that this process goes well together with consolidation as well as third party material handling. The reason why it works well together is that the construction of housing is standardized to a larger extent with the order materials are brought in, but the interviewee sees future possibilities with implementing consolidation in commercial projects. Another reason behind the lower willingness to work with logistical tools from the commercial side was presented by Interviewee 4, the issue is that the calculation tool that the logistics group utilizes to calculate the economical effects from implementation is a general lack of data on commercial buildings and that there are more projects specific aspects to be taken into account. Interviewee 9 thinks that as long as there are multiple organizations on-site the requirements on adequate coordination will increase to make sure that all parties are playing by the same rules, for them the housing or commercial aspects are not the decisive factor related to the logistics rather the interactions between multiple organizations. The literature suggests that sites with multiple actors often lack coordination, and especially between main contractors, to solve this the proposed implementation of a TPL as responsible for the logistics can benefit sites with coordination of the activities with all the involved actors.

Interviewee 3 notes that the use of logisticstools varies with the size of the project. For projects with only a few deliveries per day, it is simpler to forgo the delivery calendar and record the deliveries on a whiteboard instead. However, the bigger a project gets, the more deliveries get booked and the interviewee explains that three deliveries cannot just arrive at site as they would not be able to handle the unloading. Furthermore, the space on sites matters when it comes to implementation, as brought up previously the site conditions are affected by storing materials on site but in some projects the possibility does not exist. In Interviewee 11 current project the deliveries would not be possible without consolidation and the delivery calendar as there exist almost no storage possibilities combined with a very small unloading bay that can barely fit one truck. Additionally, the project will use dedicated material handling personnel, the solution is very similar to the one proposed in the literature with the exception of having a TPL company that is responsible for the logistics pointing to more complex projects utilizing construction logistics to a greater extent because of site-specific reasons.

5
Discussion

In this chapter, we will dive into our analysis, offering further insight and perspectives on the subject matter. It is important to note that the content presented herein will predominantly consist of interpretations and perceptions rather than concrete factual data. Therefore, the discussions within this chapter should be approached with this understanding in mind.

5.1 Health & Safety

Safety and health are paramount in the workplace, and the Swedish safety culture is characterized by a strong awareness that all employees should return home unharmed after each workday. It is evident that the risk factors identified in the literature constitute a significant cause of accidents within the construction industry, which is also confirmed by the empirical study and the interviews conducted. However, despite this awareness, the question remains: why do so many accidents still occur when we are well aware of where the risks are?

We think that part of the answer may lie in the lack of adequate resources to implement the necessary safety measures. Increased resource allocation is crucial to ensuring that sufficient funds are available to hire more safety personnel, invest in safety equipment and tools, and allocate time for training and safety briefings. Although it is clear what actions should be taken, such as providing safety introductions to new professionals on the construction site, gaps in resources or prioritization often hinder full implementation. We have observed that those responsible sometimes lack the time to perform the necessary tasks, despite their willingness. There is a noticeable disconnect between the described safety requirements and the actual possibilities available to the on-site workers. Additionally, the safety instructions sometimes contain loopholes which, in stressful situations, can be the easy way out to save time, even though this may create unsafe conditions.

5.2 Construction Logistic

The hesitation towards new things is not a revolutionary concept within the construction industry but is present within construction logistics, although once the person has tried utilizing logistics tools in their projects, they are generally positive towards them. This clashes with the fact that the tools are not being used to their full potential in many of the cases. The reasoning behind this is somewhat unclear,

but one speculation could be the resource allocation towards logistics within the organization. Only a limited number of logistics engineers exist to help projects with the implementation, and once implemented few projects have an on-site logistician that is capable of utilizing the tools to their full extent. This is something that can be further developed in the future, but the current economical situation causes organizations to focus on the more traditionally important construction activities. However, investing in logistics during a less fortunate economic situation could be a good idea in order to win more procurement's as a good logistics solution can reduce the costs and therefore provide a competitive advantage. Additionally, the notion of logistics on-site always working to a certain degree seems to exist and might be one of the underlying reasons to the lesser focus on the subject.

Another issue presented related to the economic situation currently is that there is a large variation in the procured subcontractors. The empirical study highlighted the fact that it is hard to motivate a TPL to handle material during economic hardships because the firm has to let other employees go. Considering that all projects have varying needs for handling materials on site, the introduction of dedicated material handlers during times with less active projects could also be one way to keep employees within the organization while developing their knowledge further when it comes to logistics. This could also facilitate the simpler organization mentioned previously possibly enhancing the safety from the aspect of knowledge regarding rules and routines.

From a managerial perspective, adapting new logistics tools might seem like an added activity that will cause further stress during the projects timeline. Considering the amount of time that logistics already take, learning a new skill might seem as too big of a challenge, but if the project has the possibility of implementing a logistics manager this could be circumvented. However, the general perception seems to be that the projects cannot afford having one but from the organizational side the implementation of logistics managers could be viewed as a tool that helps implementation of logistics tools while helping the managers focus on other tasks on site. The goal should be effective implementation of the tools that exist, and considering the interview answers, the current practice is not as optimal as it can be.

5.3 Logistics& Safety

Effective enforcement within construction logistics has revealed itself as an area where there exist potential for improvement. Many of the issues seem to stem from the problem solving mindset that exists in the industry and this might lead to organizations having to force their projects to implement logistical tools. However, this needs to be done with finesse to make sure that the implementation does not cause a reversed effect by changing the opinion to more negative. One way to do this could be to perform a more in-depth investigation to make sure that the project is appropriate for a certain tool. With this said certain tools are applicable to most projects like the logistical plan, in this the problem does not seem to be

low implementation but rather the way it is used once implemented. Currently the punishment for not implementing or not using it correctly seems to be nonexistent as long as the project goes well, but in order to change, even projects that are in the green economically need to have consequences if the tools required are used incorrectly. Additionally, if used incorrectly, the benefits in both efficiency and safety become questionable, making the investment of implementation less valuable. From the empirical study, the lack of investments in monitoring the implementation of the tools is shown. From the researchers point of view, there seems to be a need for more resources to be invested in actually following up the usage to find good and bad examples, but this is relevant to all of the logistical tools. However, the construction industry might be one of the hardest industries to try and make this change, as many enjoy the freedom the projects have, as well as the challenges that come with problem solving, and do not want this to change anytime soon.

In the study, the connection between utilizing a CCC and furthering safety of delivery drivers was found, but depending on the manner in which the transport is set up, this could enhance safety. One example of this could be to utilize the same chauffeurs repeatedly, as this would build their knowledge on how Skanska's rules and routines work. Another benefit could be that information regarding the rules and routines could be provided to the chauffeurs during the loading at the CCC making sure that even if the information sharing at the site fails, the driver has the correct information.

A reoccurring theme for the commercial side of projects is the possibilities for storage but not realising the possible dangers related to this. But this behaviour will probably not just stop by itself there needs to be measures implemented to hinder it. One example of preventing it could be forcing the actors on site to implement more takt planning, considering that this has facilitated the implementation of logistical tools such as CCC's this could be a step towards the right direction but the exact effect is hard to predict. Another way of reducing the storage could be forced implementation of CCC's pushing the storage to facilities outside the site in order to reduce the risks but the previously brought up negatives aspects that come with forced implementation has to be weighted against the positives.

5.4 Societal, Ethical & Ecological Aspects

In the realm of construction, the implementation of logisticstools holds significant promise not only in improving efficiency but also to improve health and safety standards. By streamlining processes and reducing hazards, these tools contribute to a culture of safety within the industry. Moreover, their role in reducing accidents and injuries has far-reaching societal implications, safeguarding the health and livelihoods of construction workers. This not only leads to lower healthcare costs but also improves public trust in the construction sector. In addition, effective logistics can lead to reduced traffic congestion and a more pleasant environment. This contributes to a positive societal impact by improving the overall quality of life of workers and residents in the area.

However, as we navigate this terrain, ethical considerations loom large. Ensuring fairness, transparency, and respect for human rights is paramount as companies integrate these tools into their operations. Ethical dilemmas, such as concerns about job displacement or intrusive surveillance, underscore the need for a thoughtful and principled approach. On the ecological front, logistical tools offer opportunities for sustainability. By optimizing resource use, minimizing waste generation, and reducing carbon emissions, they contribute to a greener construction industry. This not only conserves natural resources, but also promotes ecosystem preservation.

In conclusion, the integration of logistical tools in construction represents a multifaceted endeavor with societal, ethical, and ecological dimensions. By navigating these aspects thoughtfully and responsibly, we can harness the full potential of these tools to create safer, fairer, and more sustainable construction practices.

6
Conclusion

In this concluding chapter, the findings related to the aim and concluding reflection on how the broader goals of the thesis have been achieved will be discussed. Following that, a brief overview of the finding related to the research question of the thesis will be presented. Lastly, thoughts on further research within the field will be discussed.

The purpose of the thesis was to examine how the implementation of logistics tools and occupational health and safety correlate, investigate how logistics and safety evolve in a complex construction project, and justify construction logistics by its benefits to on-site safety, aiming to initiate conversations related to these subjects by creating a broader understanding of where and why people take risks. Through the research conducted, it became evident that the integration of logistics tools can improve safety measures on construction sites, highlighting that well-planned logistics not only streamlined operations but also minimized potential risk, thereby fostering a safer work environment. This correlation between efficient logistics and enhanced safety underscores the importance of strategic planning in construction projects. Furthermore, the study revealed specific areas where risks were commonly taken, providing valuable insights into the behavioral patterns of workers, which can serve as a foundation for developing targeted safety protocols and educational programs aimed at reducing risk-taking behaviors. In conclusion, this thesis successfully demonstrated that the benefits of construction logistics extend beyond operational efficiency to include substantial improvements in occupational health and safety, contributing to the ongoing discourse on the importance of integrating logistics with safety measures and encouraging further research and implementation of best practices in the construction industry.

The area of our research remains largely unexplored, a realization that became increasingly evident as we delved deeper into our investigation. Construction logistics and safety represent intricately intertwined topics, each influenced by a multitude of factors. Despite the complexity inherent in these areas, we remain firm in our belief that our research has the potential to significantly benefit the construction industry. By shedding light on the intricate relationship between logistics and safety, we aim to foster a deeper understanding within the industry. As the frequency of accidents on construction sites continues to rise, it becomes imperative that all stakeholders prioritize efforts towards identifying areas for improvement. Through our research, we strive to contribute to this crucial endeavor, ultimately striving toward safer and more efficient construction practices.

The key takeaway from this report is that to ensure a safe workplace, we need to acknowledge that humans will inevitably make mistakes and build systems where the human factor contributes to errors, the system can rectify them. We believe that with the aid of logistical tools, we can construct systems where the human factor plays a lesser role, thus reducing the number of accidents on our construction sites.

6.1 RQ1: How does the implementation of logistics tools correlate with occupational health and safety on construction sites?

Implementation of logistical tools can contribute to an improvement in safety on site by ensuring that the logistics are planned in a safe manner and therefore minimize the risk of an accident. However, implementation of logistical tools is highly dependent on the way they are used, and from the information gathered during both the empirical and the literature studies the tools need to be used in the way they were designed. Deficient implementation can lead to poor results, causing a decline in the attitude towards logistical tools as a whole, possibly causing more harm than not implementing any tools at all. To avoid the harm caused by faulty implementation, effective enforcement is necessary, from the empirical study the indication that a more strict implementation would lead to more beneficial results. However, there are benefits with the freedom given to projects currently making the selection of when to enforce implementation important as forced usage of tools in project where the benefits of certain tools do not exist can cause harm to the opinion towards them. To ensure the adoption of appropriate measures for risk reduction, logistics must be meticulously planned at an early stage, with input from all relevant stakeholders regarding potential risks and corresponding solutions. Research indicates that identifying risks early in a project leads to more cost-effective solutions, incentivizing projects to prioritize this approach. Both empirical evidence and the literature highlight that thorough planning of vehicle routes, along with designated loading and unloading areas, improves on-site safety and promotes cost-effective logistical operations.

6.2 RQ2: Which aspects within construction logistics can be identified and measured to comprehend their impact on safety at a construction site?

Measuring safety on a constantly changing construction site is indeed challenging due to the significant influence of individual behavior, making it nearly impossible to establish fixed measurements for specific tools or practices. However, pinpointing high-risk areas such as loading/unloading zones and tripping hazards, and utilizing

logistical tools to reduce on-site traffic, may lead to more concrete outcomes. Documenting all deliveries using a delivery schedule and assessing delivery quantities, particularly with co-loading practices, can help measure safety. Additionally, pre- and post-surveys can gauge perceived on-site safety. Quantifying the impact of logistics on safety requires further studies on similar projects, but measurable aspects like the reduction in on-site trucks following a Consolidation Center implementation can serve as proxies for overall site safety. Evaluating the frequency of untimely deliveries through a delivery calendar can also assess the working conditions of the unloading team, while considering the underlying reasons for risk-taking behaviors.

6.3 RQ3: What are the key determinants that drive construction workers to exhibit a willingness to take risks and bypass safety measures, specifically in the context of on-site logistics?

Our research indicates that a significant determinant is the lack of resources. Despite acknowledging the importance of safety, implementation often falls short due to insufficient resources or prioritization. Those responsible for safety frequently lack the time to carry out necessary tasks, despite their willingness. The findings reveal that construction workers engage in risky behaviors due to various factors. Stress leads workers to take shortcuts and bypass safety protocols. The construction industry demands problem-solving, which many workers enjoy. They take pride in completing tasks swiftly and efficiently, deriving satisfaction from overcoming challenges. Competition exacerbates this tendency, and under stress, workers may struggle to adhere to safety protocols. Additionally, workers sometimes intentionally take shortcuts or skip safety steps to expedite tasks, driven by laziness or a belief that the likelihood of an accident is low. These intentional acts are complemented by unintended risks when workers become habituated to their environment and fail to recognize hazards. They may also overlook dangers posed by others' activities on the construction site, inadvertently engaging in risky behaviors. Our study highlights the impact of experience and age on safety dynamics. Older, more experienced workers adopt safer practices but suffer more severe consequences from accidents due to slower recovery times. Conversely, younger workers are more inclined to take risks but recover more quickly from minor injuries, underscoring the complex interplay between experience, age, and safety behavior. Furthermore, the general attitude towards safety can be quite low. Some workers perceive safety education and planning, such as lifting plans, as formalities rather than essential practices. This lack of genuine concern for safety protocols contributes to risk-taking behaviors.

6.4 RQ4: In the context of complex projects, like Lilla Backa, what specific shifts in logistics planning are required and how do they effect the safety?

In complex projects the logistics solution is largely down to the project management and their preferences, the difference found between residential and commercial buildings was the difference in usage of CCC's and TPL's. The underlying reason found was the increased availability of storage in commercial projects, a less standardization, and a less use of takt planning. Multiple organizations creates higher requirements on the coordination between the actors and according to the literature this often is not the case. The coordination needs to include the blue collared workers as well as unforeseen challenges might occur with employees that will interact with building aspects that they are unfamiliar with. To facilitate greater coordination, both the empirical and the literature study recommended that projects invest in hiring an on-site logistician, this has the added effect of reducing stress and time for a projects management team. Storage on-site is sometimes described as a benefit in the empirical study that allows the projects to have easily available materials. However, the concerns with material storage on-site were raised in both empirical and literature studies, with the main negative being material and personnel damage during storage. The possibility of storage in residential projects is lower in comparison, and in projects that have available storage space, this might cause decreases in the inventory on-site.

6.5 Suggestions for Further Research

As previously mentioned, there are several aspects within this field that warrant further investigation. One beneficial project could involve demonstrating the impact of a logisticstool on safety. This would need to be performed on two similar projects during the same period or on the same project over time, ensuring that conditions such as weather, project teams, and other variables remain consistent.

Additionally, the literature and our study highlight a significant gap in research and focus on the role of subcontractors in construction logistics. Given that subcontractors play a crucial part in on-site logistics and safety, this area deserves more attention and could contribute valuable insights to the field.

During the empirical study, suggestions for improvements emerged, indicating that with some planning, loading and unloading processes could be made safer. One specific area for further exploration is the implementation of asphalted loading and unloading zones in projects where asphalting is already planned. Additionally, standardizing procedures for securing loads could also enhance safety on construction sites

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A

Appendix 1

In Appendix 1, regulations and directives related to loading and unloading at construction sites have been compiled.

Table A.1: Table illustrating The Swedish Work Environment Authority's Collection of Regulations (AFS 1993:3)

AFS 1993:3	
15§	A building work environment co-ordinator as referred to in Chap. 3, Section 7 b of the Work Environment Act shall supervise measures to verify that technical devices are duly inspected and tested and also that drivers of such devices have sufficient competence or, where applicable, the requisite permits.
46§	Suitable equipment shall be provided for lifting and conveying building products and other material, if needed in order for the employees not to be subjected to loads which are dangerous to health or unnecessarily fatiguing. The lifting devices and accessories chosen, including their component parts, attachments, anchorings and supports, shall be properly designed and constructed and sufficiently strong for their intended use, and shall clearly display their maximum load values. Lifting devices and accessories shall be operated by qualified workers who have received appropriate training, and may not be used for other than their intended purposes

Table A.2: Table illustrating The Swedish Work Environment Authority's Collection of Regulations (AFS 2006:6)

AFS 2006:6	
3§	Working conditions shall be investigated and the hazards assessed when lifting devices and lifting accessories are to be used. The following shall be particularly investigated: 1. the stability of the lifting devices in different ground and weather conditions, 2. access to danger zones, 3. the practical and theoretical knowledge possessed by the employees, 4. work beneath an elevated load and hoisting of persons, 5. servicing and assembly work, 6. use and selection of lifting accessories, 7. securing of load, load coupling and manual load control, 8. coincident work zones and use of several lifting devices for lifting a common load (tandem lifting) and 9. the life expectancy and maintenance of lifting devices and lifting accessories
9§	Work using lifting devices and lifting accessories shall be planned, organised and conducted in such a way that dangerous situations are avoided. In connection with lifting operations where representatives of several activities are involved, one person shall be placed in charge of planning and conducting the lifting operations.
18§	When two or more devices for lifting loads have been installed or assembled at a worksite in such a way that their work zones partly coincide, measures shall be taken to void collisions between the loads or devices. When a device for lifting a load or personnel is used in the place where there is a risk of the device being run into by another vehicle, measures shall be taken to prevent this from happening.
24§	If the operator of a device for lifting a freely suspended load does not command an adequate view of the entire lifting zone, either directly or with auxiliary equipment, a person competent for the task shall be in direct contact with and guide the operator. The work shall be organised in such a way that the load cannot move in a dangerous manner.
25§	The person securing or detaching a load manually shall be able to do so safely by having control of the lifting device or being in direct contact with the person operating the lifting device.

26§ For work requiring manual alignment of a load, a lifting device shall be used which can be regulated so as to afford good control of the lifting operation.

29§ A lifting device or lifting accessory may be used only by a person who is closely familiar with the work and has the theoretical and practical knowledge needed for safe use. This knowledge shall include current work environment rules and relevant aspects of the lifting device's and lifting accessories' 1. structure, 2. operation, 3. maneuvering, 4. properties, 5. uses, 6. limitations, 7. maintenance and 8. inspection. An employer ordering an employee or outsourced worker to use lifting devices or lifting accessories shall have documentation concerning that person's practical and theoretical knowledge with regard to safe use of the equipment. A worker to whom subsection one of this section does not apply but who uses lifting devices or lifting accessories at a common worksite shall have corresponding documentation available at the worksite. Employees and outsourced personnel shall have written permission from the employer and hirer respectively to use a mechanically powered lifting device. The permission shall indicate the types of lifting device, lifting accessory and duties included. These requirements concerning documentation and permission do not apply to the use of hoists/lifts.

Table A.3: Table illustrating The Swedish Work Environment Authority's Collection of Regulations (AFS 2006:4)

AFS 2006:4	
15§	If an item of work equipment is likely to involve a specific risk of ill-health or accidents, the work shall be arranged in such a way that only the persons tasked with using the equipment are allowed to do so. Those attending to inspection, repair, alteration, servicing, cleaning and maintenance of such equipment shall be specially appointed.
16§	An employer appointing an employee or outsourced manpower to use work equipment as referred to in Section 15 shall have documentation of that person's practical and theoretical knowledge regarding safe use of the equipment. A worker not coming within the scope of the foregoing but using work equipment as referred to in Section 15 at a common workplace shall have corresponding documentation available at the workplace.

Table A.4: Table illustrating The Swedish Work Environment Authority's Collection of Regulations (AFS 2006:7)

AFS 2006:7	
15§	An employer shall appoint a person to lead the work with personal lifts. The employer shall ensure that the person in question has sufficient knowledge and access to necessary information. An employer who applies group inspections shall have a current list of individuals included in each respective group. (AFS 2010:3)

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