Construction logistics status and actors' opinions – an industry wide survey in Sweden

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Abstract

Purpose – The purpose of this paper is to investigate whether construction logistics services are still carried out mostly in an *ad hoc* manner, or has advanced to a more standardized, strategically implemented practice and to explore different actors' attitudes towards construction logistics.

Design/methodology/approach – Unlike previous studies of construction logistics, relying on single or multiple case studies, a survey was designed to deliver a generalizable snapshot of contemporary industry practices and the status of construction logistics. A total of 902 responses from the Swedish construction industry were collected with the help of the industry wide questionnaire.

Findings – The results show that construction logistics setups (CLSs) are only used by 14% of the responding organizations, which confirms that construction logistics services are still mostly carried out in an *ad hoc* manner. This may change considering that respondents with more experience in the industry claim an increased demand for CLSs. The *ad hoc* approach is less common among contractors than other types of organizations and large organizations. Furthermore, there is a more positive attitude towards the benefits of construction logistics among the respondents from organizations having a standard CLS.

Originality/value – This is the first industry wide survey presenting the status of implementation level of standardized logistics services in the construction industry and the attitudes among industry actors towards logistics.

Keywords Construction logistics, Construction logistics setups, CLS, Survey

Paper type Research paper

Introduction

The low productivity of the construction industry has been highlighted in several studies (e.g. Barbosa *et al.*, 2017). Lack of well-functional logistics has been identified as a common

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explanatory factor for the lack of efficiency, low productivity and project cost overruns in the construction industry for more than two decades (Agapiou *et al.*, 1998; Vrijhoef and Koskela, 2000; Sundquist *et al.*, 2018). Construction projects are typically material intensive and generate large amounts of transports to and from sites (Josephson and Saukkoriipi, 2007; Dubois *et al.*, 2019), wherefore managing construction logistics is important to improve productivity (Sezer and Fredriksson, 2021; Fadiya *et al.*, 2015). Construction logistics can be divided into two primary functions: the management of logistics activities *on* construction sites (on-site logistics), and the transport of resources and materials *to and from* construction sites (off-site logistics) (Ghanem *et al.*, 2018).

The management of the on-site logistics impact on the productivity in the project (Josephson and Saukkoriipi, 2007). Studies show that a project receives between 2 and 10 deliveries a day, corresponding to about 8–10 tonnes material and the logistics costs are about 30%–40% of the production cost (Guerlain *et al.*, 2019). On-site construction logistics has traditionally not been seen as an important task to manage among the site actors. For example, studies report that Swedish construction workers spend on average over 50% of their time waiting for and handling materials (Josephson and Saukkoriipi, 2007), and Thunberg and Persson (2014) report that less than 40% of the deliveries arrive to site on time and with the correct content. However, it is not only the Swedish context that suffers from low productivity, reports from, for example, the UK indicate similar numbers (Department for Business Innovation and Skills, 2013), and Mckinsey and Company (2017) point to low productivity in general internationally. Regarding off-site construction and the environmental impact of construction logistics, Swedish studies show that construction transports generate about 10% of the carbon dioxide emissions during the construction time (Sezer and Fredriksson, 2021) with only 60% transport efficiency (Naz *et al.*, 2022). Studies from Belgium and the UK also provide evidence of high environmental impact from off-site construction logistics (Transport for London, 2013; Brusselears *et al.*, 2023).

Regarding construction logistics services, there is a wide consensus regarding the potential to improve efficiency and sustainability (see e.g. Agapiou *et al.*, 1998; Akintoye *et al.*, 2000; Vrijhoef and Koskela, 2000; Ying *et al.*, 2014; Sundquist *et al.*, 2018; Sezer and Fredriksson, 2021). Therefore, construction logistics should be a key concern in the construction industry. However, improvements of construction logistics are challenged by the project-based organization with a lack of well-defined, in-house, continuous processes (Smyth, 2010; Backlund and Sundqvist, 2018). Therefore, the purpose of this paper is to investigate whether construction logistics services are still carried out mostly in an *ad hoc* manner, or has advanced to a more standardized, strategically implemented practice and to explore different actors' attitudes towards construction logistics. The study is based on an industry wide survey conducted in Sweden during 2021.

Presently, we know little about the attitudes and the implementation rate of CLSs, which is a bundle of construction logistics services, on an industry level in any European country. There is a need for an industry wide survey to capture the present status of implementation as previous research on construction logistics is case-based, where several studies cover the same projects, typically large and prestigious projects with very challenging logistics features, and as a result, resources have been devoted to applying more sophisticated logistics solutions. Two frequently studied projects in Sweden are The Future University Hospital in Linköping (e.g. Ekeskär and Rudberg, 2016; Sundquist *et al.*, 2018) and the Stockholm Royal Seaport in Stockholm (e.g. Janné and Fredriksson, 2019; Hedborg Bengtsson, 2019). The only evidence beyond such single case studies are a few multiple case studies: Fredriksson *et al.* (2021) comparing 13 different CLSs in Sweden, Guerlain *et al.* (2019) comparing four different CLSs in Italy, France, Spain and Luxemburg and Janné *et al.* (2019)

comparing five different CLSs in Nordic hospital projects. Considering that large and prestigious projects only represent a small percentage of the construction industry, it is difficult to make claims about the status of construction logistics, the attitudes and the degree of implementation at the industry level from these previous studies. Hence, a nationwide survey that capture the present status of construction logistics on a wide scale fills a gap in state-of-the-art knowledge. It is also worth to note that earlier case-based studies are mainly conducted in a European context, with examples from Sweden, the UK, Belgium and The Netherlands. Hence, even though the construction industry is mainly local, an industry wide survey in Sweden should render interest as Sweden is to be seen as a forerunner of construction logistics.

Theoretical background

The theoretical background first presents the development of construction logistics as a practice identified in previous research, providing an understanding of the possible gains and risks to be expected from implementing construction logistics. Secondly, the specific logistics services that are commonly used are presented as a background for the variables included in the survey. They are summarized in Table 1.

Construction logistics development

Construction logistics can be defined as:

> Providing a construction site with resources in the form of materials, machines and personnel in an efficient manner along with managing resources efficiently on the construction site itself as well as ensuring efficient recycling and waste management that enables circular economy and durability (Janné and Fredriksson, 2018).

Accordingly, construction logistics entails the coordination of materials and resources to, from and at the construction site (Janné and Fredriksson, 2019). Previous case studies show that an efficient and effective construction logistics reduce costs, increase quality, contribute to shorter construction time period and decrease environmental emissions (e.g. Sezer and Fredriksson, 2021; Janné and Fredriksson, 2019; Dubois *et al.*, 2019; Hedborg Bengtsson, 2019; Sundquist *et al.*, 2018; Ekeskär and Rudberg, 2016).

The organizing of construction logistics has during the years been studied from several perspectives. During the 1990s and early 2000s, the construction industry's lack of productivity due to shortcomings in logistics management were highlighted (Egan, 1998; Josephson and Saukkoriipi, 2007; Nicolini *et al.*, 2001). This led to the emergence of research and development efforts in the construction logistics and SCM (Strategic Forum, 2002; Vrijhoef and Koskela, 2000). The starting point for the development was four roles of SCM and logistics in the construction described by Vrijhoef and Koskela (2000): 1) focus on clarifying the interface between the supply chain and site activities with the goal of reducing the duration and cost of site activities through improved reliability in the delivery of goods and resources; 2) focus on improving the supply chain with the goal of reducing lead times and costs of transportation and inventory; 3) focus on improving logistics at the construction site to streamline materials handling times and decrease costs on site; and 4) transfer activities from the site to the supply chain to improve conditions on site or to achieve a wider concurrency between activities with the goal of reducing costs and time. Ekeskär and Rudberg (2016) added a fifth role: 5) manage the site and the supply chain as an integrated domain to accomplish integrated supply-chain planning as well as clear roles and responsibilities among actors. However, the uptake of construction logistics and SCM has been low in the industry, and therefore, earlier research were not limited to positive aspects of logistics, but research on the resistance of the construction industry towards these concepts

Table 1. Included variables in the study

Variable	Explanation	Reference (e.g.)
General opinions on construction logistics	This variable identifies how the different actors view logistics. This is important as logistics for long time have been seen as an operational issue and not strategic, and the variable allows an analysis of whether the view on logistics depend on the actor's position in the value chain	
Initiator	CLSs can be initiated by different actors, and the actors initiating have an impact on the focus of the services included. The analysis focuses on whether this was still the case and what type of CLS are most common	Fredriksson *et al.* (2021)
Developer/municipalities	Developer/municipality initiated CLSs focus mainly on services supporting third actors and decreasing environmental impact	Havenvid *et al.* (2016) and Eriksson *et al.* (2021)
Main contractor initiative	Main contractor-initiated CLSs focuses mainly on supporting on-site activities	Hedborg Bengtsson (2019)
Effects	Different studies have reported different types of effects of the use of logistics services. Therefore, the variable was included to understand what type of effects were related to which services and how were they experienced by different actors	
Risk of increased costs	Several actors, especially main contractors and developers, have expressed fears of increased costs by the introduction of CLSs	Janné and Fredriksson (2022)
Opportunity for decreased costs	Several authors have identified the possibility of decreased costs by the introduction of CLSs	Lindén and Josephson (2013), Agapiou *et al.* (1998) and Janné and Fredriksson (2022)
Reduced number of transports	Several authors have identified possibilities of reduced number of transports by the introduction of CLSs	Transport for London (2013) and Janné and Fredriksson (2019)
Improved productivity (man hours and machinery)	Several authors have identified possibilities of improved productivity by the introduction of CLSs	Lindén and Josephson (2013) and Sezer and Fredriksson (2021)
Improved safety on site	The authors have identified possibilities of improved safety by the introduction of CLSs	Ekeskär and Rudberg (2016)
Reduced disturbances and improved security	The municipalities and developers have identified possibilities of decreased disturbances in vicinity of site by the introduction of CLSs	Sullivan *et al.* (2010) and Dubois *et al.* (2019)
Improved delivery precision	Several authors have identified possibilities of improved delivery precision by the introduction of CLSs	Transport for London (2013) and Thunberg and Persson (2014)
Construction logistics services	Different studies have seen CLSs include different types of services; hence the variable was included to understand what services are commonly included and used by different actors	

(*continued*)

Table 1. Continued

Variable	Explanation	Reference (e.g.)
Standard CLS	The variable allowed the analysis of whether the actors take a strategic approach to logistics and have a standard setup of logistics services, established in projects	Janné (2020)
Checkpoint	A service used to regulate the arrivals of trucks to the site by slot time booking	Ekeskär and Rudberg (2016)
Booking calendar	A service for coordinating the use of common resources, such as unloading zones, by allowing bookings of the same	Fredriksson *et al.* (2021)
Materials handling onsite	A service for carrying the materials from the unloading zone to the place of use	Fredriksson *et al.* (2021)
Bundling of material at terminal	A service for combining the materials needed for a work and delivered at the same time	Fredriksson *et al.* (2021)
Logistics coordinator	A person hired to plan and follow the logistics work at site, ensuring that the coordination between actors is running smoothly	Sundquist *et al.* (2018), Eriksson *et al.* (2021) and Janné and Fredriksson (2022)

Source: Authors' own creation

have also been reported (Agapiou *et al.*, 1998; Vrijhoef and Koskela, 2000; Fernie and Tennant, 2013).

Furthermore, combining the perspectives of logistics and SCM presented above with the need of coordinating the construction transport with the community in the vicinity of the construction site has been studied as part of city logistics research (e.g. Fossheim and Andersen, 2017) and public and private transport (e.g. Dablanc, 2008; Fredriksson *et al.*, 2022; Goldman and Gorham, 2006; Savelsbergh and Van Woensel, 2016). This led to the introduction of a sixth role for construction logistics by Fredriksson *et al.* (2021): 6) to coordinate logistics between construction projects and society in the vicinity. This role takes the perspective of the municipality and its need to coordinate construction traffic with the rest of the traffic in the city.

Construction logistics setups and included services

The six roles presented above, aim in different ways to integrate and coordinate the construction process and the supply process (Thunberg and Fredriksson, 2023). Among the actors, the suppliers and transporters are part of the construction supply chain and the rest are part of the construction process except for the local municipality, who influence the transport options and routing (Fredriksson and Huge-Brodin, 2022). Therefore, the construction logistics system is to be seen as complex with a multitude of different relationships (Dubois *et al.*, 2019), where some relationships are more straightforward such as the main contractor supplier relationship, whereas others such as the developer and third-party logistics provider relationship is more complicated with unclear understanding of the customer role (Eriksson *et al.*, 2021). Though, decisions taken by one actor influence others, and at the same time are restricted by decisions made by other actors (Fredriksson and Huge-Brodin, 2022). For instance, the actors in the construction supply chain are dependent on the planning and decisions made by the construction process actors as well as the progress of the construction process itself. The actor perspective is also important as the industry is dominated by relatively few actors, and therefore, what these actors do will have an impact on many projects.

Due to the temporary nature of construction projects, and that each project takes place at a new location (Lundesjö, 2015), it is necessary to include logistics planning as part of overall project planning to adapt the logistics services to the specific needs of the project. Even though each project is unique there is a development of standardizing the service offering among construction logistics service providers (Gremyr *et al.*, 2023). This standardization has followed the development of the CLS concept (e.g. Janné, 2020; Fredriksson *et al.*, 2021; Ekeskär and Rudberg, 2022). A CLS is defined by Fredriksson *et al.* (2021) as:

> A governance structure for a construction project that has been agreed on to control, manage, and follow up the flow of materials, waste, machinery, and personnel to, from, and on the construction site.

A CLS has mainly two focuses:

(1) coordinating the transport and material flow of the many actors involved in a construction project, such as developers, main contractors, suppliers and sub-contractors, but also the local municipality (Fredriksson and Huge-Brodin, 2022); and

(2) solving the lack of space at the project site (Lundesjö, 2015). As an effect the services included in a CLS either focus on the management of logistics activities on construction sites, or the transport of resources and materials to and from construction sites (Ghanem *et al.*, 2018).

To match the six roles, construction logistics includes a wide array of services; some are unique to the industry, such as managing hoists and cranes and on-site storage and materials handling (Lundesjö, 2015). In their study of 13 different CLSs, Fredriksson *et al.* (2021) identified in total 16 different types of services to be offered. These services include construction logistics centre (CLC) (Hamzeh *et al.*, 2007; Janné and Fredriksson, 2019; Guerlain *et al.*, 2019) and checkpoints (Ekeskär and Rudberg, 2016; Sundquist *et al.*, 2018; Dubois *et al.*, 2019). The aim of both these services is to plan and coordinate material transports to and from the site, though the aim of the CLC is also goods consolidation to reduce the number of deliveries (Lundesjö, 2015; Janné and Fredriksson, 2019). Other types of services were logistics-based site plans (Josephson and Saukkoriipi, 2007; Transport for London, 2013), site coordination (Transport for London, 2013; Ekeskär and Rudberg, 2016; Sundquist *et al.*, 2018), materials handling on- and off-site (Ekeskär and Rudberg, 2016) and waste management (Janné and Fredriksson, 2019).

Recently, the interest in CLS has increased, both among contractors and municipalities (Fredriksson *et al.*, 2021). For projects with high complexity, such as hospital projects or large urban development projects, CLSs are used more frequently (Janné *et al.*, 2019; Janné and Fredriksson, 2019; Flinders, 2015; Kooragamage, 2015). However, the impact of implementing a CLS varies depending on whether it was planned for already during the construction planning phase or if it was introduced *ad hoc* later on in the project to solve problems related to logistics as well as transport issues during the construction production phase (Fredriksson *et al.*, 2021; Dubois *et al.*, 2019; Gremyr *et al.*, 2023). Therefore, presently, it is difficult to judge if CLS in the construction industry is commonly applied as intended to prevent problems related to logistics or as a problem-solving tool during the production.

Summary

Table 1 summarizes the variables included in the survey and how they were identified.

Methodology

A common denominator for previous construction logistics studies is the use of case studies, with either single or multiple cases, as the research approach, collecting data by conducting interviews, observations and/or using secondary data, including a number of transports, types of vehicles and package sizes. Single case studies are useful if the aim is to contribute to in-depth knowledge in terms of what construction logistics entail and provide in its context of a project. However, one disadvantage is the difficulties of generalizing the results (Eisenhardt and Graebner, 2007; Yin, 2009), especially as these studies mainly have covered large construction projects with very challenging logistics prerequisites. Although multiple case studies allow a certain degree of generalization (Yin, 2009), it is difficult to find cases that include the large variety of actors being involved and various types of projects that represent the heterogeneity in the industry. Since the purpose of this paper is to investigate whether construction logistics services are still carried out mostly in an *ad hoc* manner, or has advanced to a more standardized, strategically implemented practice and to explore different actors' attitudes towards construction logistics, an industry wide survey was conducted. Unlike case studies, conducting a survey and using a questionnaire enabled that a generalizable snapshot of the industry is captured taking into consideration the heterogeneity of actors and projects. The study is limited to the Swedish context only. Though, the Swedish construction industry is organized in a similar manner as the rest of the Nordic countries. Hence, the results should be generalizable at least within such a setting. Furthermore, several Swedish organizations such as Skanska act on an international scene and in combination

with increasing demand on construction logistics also seen on the continent Belgium (e.g. Brusselears *et al.*, 2023), Austria (Grenzfurtner *et al.*, 2023) and The Netherlands (van Merriënboer *et al.*, 2023).

The questionnaire

The questionnaire was developed by three researchers from two Swedish Universities and distributed by a Swedish company, "Byggfakta" during May-June 2021. The questionnaire contained two parts:

(1) a general part with background information of the respondents and their attitudes towards construction logistics; and

(2) questions regarding the implementation of construction logistics in a specific project (the project was either selected by the respondents as a representative project or a project from the Byggfakta database which they according to the records were part of).

In total the questionnaire included 37 questions, either multiple choice or free text. The questionnaire was tested by actors from the construction industry before sent out. Also, Byggfakta's experienced callers checked the questions based on how respondents would grasp the content and some minor updates were done to increase the understandability and response rate.

Sample

Byggfakta compiles a database of all past and upcoming projects in Sweden. Construction industry organizations subscribe to this database to get knowledge of possible future business opportunities. Thus, Byggfakta has access to wide range of decision makers within the construction industry representing different actors such as developers, consultants, contractors and municipalities. Based on discussions between the researchers and Byggfakta it was decided to only include housebuilding projects of all types (new construction, refurbishment and extension as well as residental, offices, etc.) with a budget larger than 10 MSEK (approximately 920k euros). The reason for this was that housebuilding and infrastructure project logistics differ extensively, and as most previous studies of construction logistics have focused on housebuilding projects, it would be more interesting to cover housebuilding also in the survey as to allow for comparison of results. It was decided to not include minor maintenance projects as small projects have not been focused upon in earlier research, and hence, the potential of implementing construction logistics, therefore, not been described. Both upcoming and ongoing projects were included. This resulted in 17,155 individual addresses of potential participants. An online survey was distributed via email, and in total, three reminders were sent out. It was also decided that 800 individual responses would be enough, considering that such industry-wide questionnaires have approximately 5% response rate (e.g. Larsson and Rudberg, 2023). Therefore, to reach the decided response rate, Byggfakta also made phone calls to receive additional responses. In total, 902 individual responses were collected, i.e. a response rate of 5.3%. Thus, the targeted response rate was met.

Respondents are employed by a variety of construction organizations. Half of the respondents work in construction developers/clients (n = 443, 50%), while a third of the respondents work for contractors (n = 288, 33%). The rest of the respondents are employed by consultants and municipalities (13% and 4%, respectively). When it comes to the size of the organization of the respondents, 35% (n = 309) belonged to small organizations (0–50 employees), 27% (n = 245) belonged to medium sized organizations (51–250 employees) and 38% (n = 339) belonged to

large organizations (more than 250 employees). The construction developers had an even distribution between small, medium and large organizations, while only 19% of the contractors were small. The majority of consultants (64%) were small organizations unlike municipalities, which were mostly large organizations (76%).

Respondents had various years of experience in the construction industry. A total of 10% had less than five years of experience, 11% had 6–10 years of experience, 27% had 11–20 years of experience and 52% had more than 20 years of experience. Respondents were grouped into different occupations based on their job titles: 70 working as chief executive officer (CEO)/owner (9%), 67 working as senior manager (8%), 98 working in design-related roles (12%), 127 working in production-related roles (16%), 369 working as project managers (41%), 29 working as facility managers (3%) and 37 working with purchasing (4%).

Non-response bias was assessed by comparing early responders with late responders. For that purpose, *t*-test was used for comparing the Likert scale items and chi-square test was used to compare categorical variables (e.g. organization size and organization type of respondents). In all the tests, differences between early and late responders were insignificant ($p > 0.05$). Non-respondents were also identified via phone-calls and the reasons were: changed workplace, the number is not working, vacation, sick-leave or referred to another person.

Data analysis

The questionnaire analysis included descriptive statistics and several statistical tests for comparison. Considering the sample size ($n = 902$), there was no need to test for normality. To compare organizations of different sizes (small, medium and large) and their use of standard logistics solutions (yes, no), chi-square test was used. For comparing organizations of different sizes and whether they offer multiple or single standard logistics solutions, the Mann-Whitney U test was applied. Although Mann-Whitney U test is a non-parametric test, it was applied because the number of standard logistics solutions was ordinal data where a test comparing mean ranks would fit better instead of the *t*-test relying on mean values. For comparing opinions of individuals based on their years of experience and roles, one-way analysis of variance (ANOVA) test was used.

Results and discussion

The results show that construction logistics services are still carried out in an *ad hoc* manner. This makes it important to understand opinions of different actors working in organizations where construction logistics services are carried out *ad hoc* or planned, as the use of CLSs are intended to prevent problems and contribute to an overall improved performance, whereas introducing these services as a problem-solving approach when the project is up and running comes with additional costs, but not necessary any efficiency, productivity or sustainability gains.

Ad hoc versus planned construction logistics

Having standard CLSs indicate that the organizations have developed strategies for construction logistics where the aim is to use these standard CLSs in projects. As Table 2 shows, only 14% ($n = 102$) of the organizations had developed standard CLS within the organization which means standard CLSs are so far relatively uncommon in the construction industry, confirming results of previous studies, i.e. cases of where CLSs are used but not adopted as an organization standard for planning logistics of their projects. Compared to other actors, standard CLSs were most common among contractors (69%), especially among large contractors (see Table 2). The results are expected considering that it is contractor's that

Table 2. Presence of CLS among the organizations of different sizes

Type of CLS	All sizes	0–50 employees	51–250 employees	>250 employees
Standard CLS		$\chi^2(2) = 17.051$, $p < 0.001$		
Exists	102 (14%)	25 (9.8%)	23 (10.5%)	54 (21.3%)
Does not exist	626 (86%)	229 (90.2%)	197 (89.5%)	200 (78.7%)
Checkpoint		$\chi^2(2) = 0.042$, $p = 0.979$		
Exists	23 (23%)	6 (24%)	5 (21.7%)	12 (22.2%)
Does not exist	79 (77%)	19 (76%)	18 (78.3%)	42 (77.8%)
Booking calendar		$\chi^2(2) = 11.942$, $p = 0.003$		
Exists	64 (63%)	13 (52%)	9 (39.1%)	42 (77.8%)
Does not exist	38 (37%)	12 (48%)	14 (60.9%)	12 (22.2%)
Materials handling		$\chi^2(2) = 3.959$, $p = 0.138$		
Exists	48 (47%)	8 (32%)	10 (43.5%)	30 (55.6%)
Does not exist	54 (53%)	17 (68%)	13 (56.5%)	24 (44.4%)
Bundling at terminal		$\chi^2(2) = 20.150$, $p < 0.001$		
Exists	45 (44%)	6 (24%)	4 (17.4%)	35 (64.8%)
Does not exist	57 (56%)	19 (76%)	19 (82.6%)	19 (35.2%)
Logistics coordinator		$\chi^2(2) = 2.686$, $p = 0.261$		
Exists	57 (56%)	13 (52%)	10 (43.5%)	34 (63%)
Does not exist	45 (44%)	12 (48%)	13 (56.5%)	20 (37%)

Source: Authors' own creation

control and plan the material flows and coordinates between the logistics on and off-site (Fredriksson *et al.*, 2021).

The results show that there are a variety of types of CLS configurations used, where most are small scale CLSs, using delivery calendars and logistics coordinators to control the flow of material at the site. This is not what is commonly seen in the case studies where almost all build on terminals or check-points to decrease the number of transports to site. One explanation to this difference is the focus in previous case studies on mainly flag-ship projects in city centres or hospital projects, where a terminal is needed to avoid disturbances to vicinity (Sundquist *et al.*, 2018).

Size of an organization might determine their ability to use specific standard services where larger organizations are expected to be more standardized as they have central resources who can invest time in developing overall strategies to be implemented in several projects. The results here confirm that standard CLSs are significantly more common among large construction organizations (21.3%), compared to medium (10.5%) and small sized organizations (9.8%) (see Table 2). Regarding specific logistics services, use of checkpoints, materials handling and logistics coordinator did not differ significantly between organizations of different sizes. However, organization size influenced the implementation of two logistics services significantly:

(1) delivery calendar where large organizations (77.8%) and small organizations (52%) implemented it more often than medium sized organizations (39.1%); and

(2) bundling at terminals which is mostly implemented by large organizations (64.8%).

All the different CLSs (except checkpoints), representing a "standardized toolbox" of logistics services, were implemented mostly by large organizations, indicating that smaller construction organizations have, as expected, a more *ad hoc* approach to logistics.

Among the organizations that use standardized CLSs, 97% of the main contractors representing large organizations use a delivery calendar in their standard CLSs (see Table 3), although it is less common among small and medium sized contractors and if all types of organizations are included (see Table 2). This is in line with previous studies suggesting that a delivery calendar or booking system is a key part of a CLS as it allows coordination between the other services as well as between the actors involved in the material flow (Fredriksson *et al.*, 2021). Bundling at terminal is most common among large organizations (Tables 2 and 3), which is expected considering that bundling at terminal requires a certain size to be implemented as a standalone solution (Lundesjö, 2015). It is implemented as a CLS among smaller organizations as well, owing to material suppliers offering these types of services (Thunberg and Fredriksson, 2023), which does not require investment or long-term contracts with large logistics suppliers (Lundesjö, 2015).

Organizations can offer a CLS with one or several services at the same time. The results showed that 37 of the organizations offered only single services (36%), 19 offered two services (19%), 18 offered three services (18%), 18 offered four services (18%) and ten of them offered all five of the services included in the survey (10%). Comparing organizations of different sizes and the number of services they offer at the same time with the Mann-Whitney U test showed that there is no difference between small and medium sized organizations ($p = 0.991$), however, there is a significant difference between small and large sized organizations ($p = 0.013$) and medium and large sized organizations ($p = 0.004$). Large organizations offered a greater number of services (2.89) compared to small (2.04) and medium sized (1.91) organizations (see Table 4).

Bundling several services into one CLS as a combination of the mentioned services is interesting, since they together cover the six roles of logistics (Vrijhoef and Koskela, 2000; Ekeskär and Rudberg, 2016; Fredriksson *et al.*, 2021) and also indicating a less *ad hoc* approach. As mentioned already by Vrijhoef and Koskela (2000) it is necessary to gain small

Table 3. Presence of construction logistics services among the contractors of different sizes

Type of CLS	All contractors	0–50 employees	51–250 employees	>250 employees
Standard CLS		$\chi^2(2) = 8.093$, $p = 0.017$		
Exists	70 (25%)	12 (22.6%)	19 (17.6%)	39 (33.9%)
Does not exist	206 (75%)	41 (77.4%)	89 (82.4%)	76 (66.1%)
Checkpoint		$\chi^2(2) = 0.303$, $p = 0.859$		
Exists	14 (20%)	3 (25%)	4 (21.1%)	7 (17.9%)
Does not exist	56 (80%)	9 (75%)	15 (78.9%)	32 (82.1%)
Booking calendar		$\chi^2(2) = 23.651$, $p < 0.001$		
Exists	53 (76%)	7 (58.3%)	8 (42.1%)	38 (97.4%)
Does not exist	17 (24%)	5 (41.7%)	11 (57.9%)	1 (2.6%)
Materials handling		$\chi2(2) = 2.906$, $p = 0.234$		
Exists	35 (50%)	5 (41.7%)	7 (36.8%)	23 (59%)
Does not exist	35 (50%)	7 (58.3%)	12 (63.2%)	16 (41%)
Bundling at terminal		$\chi^2(2) = 20.545$, $p < 0.001$		
Exists	34 (49%)	4 (33.3%)	2 (10.5%)	28 (71.8%)
Does not exist	36 (51%)	8 (66.7%)	17 (89.5%)	11 (28.2%)
Logistics coordinator		$\chi^2(2) = 3.934$, $p = 0.140$		
Exists	42 (60%)	7 (58.3%)	8 (42.1%)	27 (69.2%)
Does not exist	28 (40%9	5 (41.7%)	11 (57.9%)	12 (30.8%)

Source: Authors' own creation

Table 4. Comparison of CLS services provided by different sizes of organizations

Size of companies	Mean rank		*p*-value
Small-medium	24.52	24.48	0.991
Small-large	30.82	44.25	0.013
Medium-large	28.15	43.62	0.004

Source: Authors' own creation

advantages through the whole flow of materials from the suppliers, all the way to the place where it is built. This requires a combination of services from the material suppliers, through the coordination of deliveries (bundling and planning of deliveries) to materials handling at sites. Hence, when a standard CLS is implemented as presented by the respondents of this study, in most cases, the designers of that CLS have logistics knowledge to understand the need of combining logistics services.

When checked in detail, the result of the survey shows that respondents from large organizations had different opinions of which services that should be considered to be standard. This can be explained due to two reasons:

(1) a majority of large construction organizations lack strategies when it comes to implementing standard CLSs based on project characteristics and, implementation of CLSs is decided *ad hoc* with subjective judgement of individuals (Thunberg and Fredriksson, 2023; Haglund and Janné, 2024) or

(2) large organizations have so contextually dispersed projects (type and geography) that they offer different standard solutions in different regions or units they have, i.e. the construction projects are so unique that there is no point in offering standard services (Fernie and Tennant, 2013).

However, the last statement can easily be contradicted if the logistics activities are studied. The roles of logistics can be standardized logistics as the activities are the same from project to project (Vrijhoef and Koskela, 2000; Gremyr *et al.*, 2023), though the project focus of construction industry make it hard to transfer knowledge from one project to another (Dubois and Gadde, 2002).

Better planning of logistics will require identification of the ideal or perfect combination of services in a CLS for specific projects depending on their location, size and type. Still a combination of standard services, though the exact combination is unique for each project (Gremyr *et al.*, 2023). Accomplishing opportunities for both scale and adaptation at the same time. Therefore, further research is needed to identify what type of construction logistics services should be combined to design a CLS that fit a certain type of project at a certain location. On the other hand, the current status shows that a majority of construction organizations (86%) still have an *ad hoc* approach when it comes to logistics, which makes it important to understand opinions of construction actors about logistics.

Actors' opinions of construction logistics

In general, the attitudes towards construction logistics are close to being neutral. While the respondents disagree to what extent construction logistics comes as a requirement during procurement, they slightly agree upon that it is a requirement during production. They also agree that there is an increased demand for construction logistics in projects and perceive construction logistics as an opportunity for reduced costs. When it comes to the effects of

logistics solutions, respondents agree on all the effects. However, the largest effects are increased delivery precision to the construction site and a more efficient use of resources (see Table 5). Respondents from organizations using standard CLSs rated all of statements higher compared to the respondents from organizations using an *ad hoc* approach (except for "I experience requirements for construction logistics in projects as a risk of increased costs"). For two of these statements, the two groups had significantly different opinions:

(1) "I believe that there are often requirements for construction logistics in procurement" ($p = 0.001$); and

(2) "effect of logistics solutions is to reduce the number of transports to the construction site" ($p = 0.032$) where both statements were rated lower by respondents from organizations with an *ad hoc* approach.

When it comes to the statements, the groups of different occupations did not have any significant differences. However, the facility managers ranked almost all statements lowest (see Appendix).

For four of the statements related to construction logistics and effects of construction logistics services, respondents with different years of experience had significantly different

Table 5. General opinions on construction logistics and its effects

General opinions on construction logistics	Mean	SD	With standard CLS	Without standard CLS
I believe that there are often requirements for construction logistics in procurement	2.78	1.356	3.18	2.74
I believe that there are often requirements for construction logistics in implementation	3.73	1.511	4.01	3.72
I am experiencing an increased demand for construction logistics in projects	3.86	1.431	4.16	3.84
I experience requirements for construction logistics in projects as a risk of increased costs	3.27	1.606	3.21	3.29
I experience requirements for construction logistics in projects as an opportunity for reduced costs	4.36	1.440	4.47	4.36
Effects of logistics solutions				
To reduce the number of transports to the construction site	4.42	1.326	4.78	4.33
To reduce the number of man-hours for craftsmen on the construction site	4.29	1.320	4.49	4.28
A more efficient use of resources in the form of crane, elevator and lull at the construction site	4.68	1.248	4.77	4.66
A reduced disruption to surrounding businesses	4.50	1.328	4.52	4.47
Improved safety at the construction site	4.65	1.219	4.69	4.63
Improved security around the construction site	4.67	1.207	4.76	4.65
Improved delivery precision to the construction site	4.68	1.204	4.88	4.65

Source: Authors' own creation

opinions (see Table 6). In general, respondents with 11–20 years of experience had lower mean values than other groups. The statement "I believe that there are often requirements for construction logistics in procurement", was ranked lowest by the group with 11–20 years (p = 0.016). When it comes to the statements, "I am experiencing an increased demand for construction logistics in projects" and "I experience procurement requirements for construction logistics in projects as an opportunity for reduced costs", there is a trend where groups with more years of experience rank them higher compared to groups with less years of experience. The same trend is observed for the statement, "Construction logistics solutions reduce the number of transports to the construction site"; however in reverse order where groups with less years of experience ranked this higher.

That the respondents with the longest time in the industry experiencing an increased demand for construction logistics and seeing it as a possibility to decrease costs is highly important. The construction industry is often claimed to be difficult to change (Hedborg Bengtsson, 2019), which is mainly because of the project focus and a risk aversion, where CLSs have been seen as a risk of increased costs (Thunberg and Fredriksson, 2023). Therefore, it is very important here that the results are confirming that

Table 6. Years in the industry in relation to attitude towards construction logistics

	Years of experience					ANOVA test
General opinions on construction logistics	0–5	6–10	11–20	21–30	>30	p-value
I believe that there are often requirements for construction logistics in procurement	2.81	2.88	2.57	2.72	2.99	0.016
I believe that there are often requirements for construction logistics in implementation	3.59	3.83	3.60	3.82	3.77	0.479
I am experiencing an increased demand for construction logistics in projects	3.36	3.84	3.67	3.94	4.09	0.001
I experience requirements for construction logistics in projects as a risk of increased costs	3.59	3.16	3.30	3.36	3.13	0.285
I experience requirements for construction logistics in projects as an opportunity for reduced costs	4.11	4.26	4.08	4.40	4.64	<0.001
Effects of logistics solutions						
To reduce the number of transports to the construction site	4.93	4.44	4.43	4.47	4.26	0.035
To reduce the number of man-hours for craftsmen on the construction site	4.31	4.02	4.20	4.38	4.36	0.337
A more efficient use of resources in the form of crane, elevator and lull at the construction site	4.73	4.66	4.78	4.60	4.66	0.715
A reduced disruption to surrounding businesses	4.71	4.58	4.49	4.49	4.45	0.760
Improved safety at the construction site	4.71	4.70	4.57	4.61	4.73	0.715
Improved security around the construction site	4.70	4.76	4.60	4.57	4.75	0.566
Improved delivery precision to the construction site	4.94	4.68	4.58	4.66	4.73	0.447

Source: Authors' own creation

the way construction logistics is seen is beginning to change which is in line with the increasing focus on construction logistics in both construction management as well as logistics research within the past few years. It might be that construction logistics is no longer seen as a new trend and may be becoming a standard, which is useful as the standardization of logistics is one of the main explanations of how other industries improved their productivity.

The relation seen between years in the industry and views on how construction logistics can assist in decreasing the number of transports is interesting. This might be explained by the shift in university education with an increased focus on environmental concerns, such as transport emissions, and the outcomes of efficient construction logistics in terms of decreasing such emissions. It is worth highlighting that respondents stated that requirements related to construction logistics lead to cost reduction and that efficient construction logistics lead to transport reduction. Among other effects, reduced emissions through improved construction logistics have mainly been reported as part of city logistics research, but to a lesser extent in construction management studies. Further research is needed to confirm why employees with different years of experience see effects including decreased costs and transports/emissions differently.

Respondents from different types of employers had significantly different opinions for four of the statements (see Table 7). Those who are employed by consultants experience an increased demand for construction logistics in projects significantly less than other groups. The other three statements, construction logistics solutions leading to:

(1) more efficient use of resources in the form of crane, elevator and lull at the construction site;

(2) a reduced disruption to surrounding businesses; and

(3) increased security around the construction site, were all ranked higher by those employed by consultants.

It is not unexpected that the attitudes and opinions related to the effects of construction logistics differ among actors in the industry (Janné and Fredriksson, 2019). This might be due to the late involvement of certain actors. According to Janné (2020), construction logistics experts are involved too late since logistics is seen mainly as an operational issue, and therefore, the effects are reduced. Though, further research is needed to explain the differences between actors as well as ways to reduce these differences.

Theoretical contributions and further research

The aim of this paper was to capture present status of construction logistics on a nation-wide level, to complement the existing case-based research. These case-based studies show a wide variety of services used as well as unclarities of the views upon the effects of logistics among the construction industry actors (see Table 1). These studies also have a bias as they focus on a few prestigious projects and not a width of projects in different settings. Theoretical implications from this study thereby manifest itself as avenues for further research to compliment the existing case-based research. First of all, this study show that construction logistics is still mainly an *ad hoc* activity among Swedish construction industry actors as only 14% have a standard CLS. Thus, this study contributes to the construction logistics literature by showing that the case-based studies are only capturing a subset of the projects and that there is a need for further research should focus on capturing how logistics is organized in smaller projects. These projects are, in most cases, not forced to use logistics because of their complex context, hence it

Table 7. Comparison of general opinions based on employer type

General opinions on construction logistics	Employer type Client	Contractor	Consultant	ANOVA test *p*-value
I believe that there are often requirements for construction logistics in procurement	2.80	2.77	2.69	0.800
I believe that there are often requirements for construction logistics in implementation	3.67	3.86	3.56	0.162
I am experiencing an increased demand for construction logistics in projects	3.87	3.98	3.42	0.007
I experience requirements for construction logistics in projects as a risk of increased costs	3.31	3.31	2.89	0.086
I experience requirements for construction logistics in projects as an opportunity for reduced costs	4.27	4.42	4.57	0.164
Effects of logistics solutions				
To reduce the number of transports to the construction site?	4.43	4.34	4.70	0.145
To reduce the number of man-hours for craftsmen on the construction site?	4.18	4.39	4.48	0.091
A more efficient use of resources in the form of crane, elevator and lull at the construction site?	4.57	4.76	4.95	0.034
A reduced disruption to surrounding businesses?	4.52	4.38	4.88	0.018
Improved safety at the construction site?	4.64	4.59	4.97	0.085
Improved security around the construction site?	4.64	4.62	5.01	0.044
Improved delivery precision to the construction site?	4.66	4.64	4.97	0.117

Source: Authors' own creation

would be relevant to understand how to organize construction logistics with a focus on improving productivity by decreasing the time used for construction activities, such as suggested by Haglund and Janné (2024) as well as Sezer and Fredriksson (2021). A research question is:

RQ1. How to design standard CLS for different types of projects and locations, which services should be combined when as to provide an adapted solution, and delivered by whom?

The existing case studies also always take a project perspective and there is a need for studies on how to develop construction logistics strategies for different actors as to provide for more standardized utilization, taking an actor perspective as in Eriksson *et al.* (2021) and Grenzfurtner *et al.* (2023). Leading to research questions such as:

RQ2. Why employees with different years of experience perceive effects of construction logistics (cost/productivity or transport emissions) differently?

RQ3. Why do different actors perceive effects of construction logistics differently?

Furthermore, there is a need to increase the understanding of how to move away from seeing construction logistics an innovation as suggested in Hedborg Bengtsson (2019) and instead it should be viewed as an activity that can be standardized and thereby experiences shared between projects. Thus: How to make construction logistics a strategic issue on among developers/clients as well as contractors, especially smaller actors? and How to include construction logistics earlier in the project planning?

Managerial and policy implications

The actors studied included construction developers/clients, contractors, consultants and municipalities. The managerial and policy implications need to be adapted to the different organizations as they have different roles in the value chain as well as in relation to initiating the use of logistics services in the construction industry (Fredriksson *et al.*, 2021). For the contractors, the lack of standardization of construction logistics services shows an underutilized potential regarding reaping the benefits of well-executed construction logistics among the same. Using standardized services is more resource efficient and the time to design a CLS for a specific project is reduced, when not starting from scratch. In other words, there will be no need to reinvent the wheel every time but just to realign it to the specific settings of the project. The larger the contractor, the more services should be possible to include in the standard setup and thereby the improving the possibilities of differentiation to specific settings of the project. Furthermore, standardized service offerings also improve learning as the workers recognize the services between projects, allowing continuous improvement efforts (Gremyr *et al.*, 2023). Hence, contractors developing a standardized construction logistics service concept decrease the risk of using CLSs in projects and increase the possibility of achieving the cost and productivity potentials identified in earlier case studies. One way to initiate the use of standard logistics services within the contractor organization is to talk of hygiene factors, starting with a few services and increasing the number of available logistics services as familiarity increases among employees as well as customers.

Developers/clients and municipalities can increase the use of logistics services by demanding the same in procurement directives, this will help to make logistics a strategic issue among the contractors. This study shows an increasing demand for construction logistics in the procurement and planning phases in a construction project. Hence, this is to some extent already taking place, though the pace of change is slow. The latter can be due to the narrow tasks given to the consultants. Requiring consultants to consider the flow of materials and resources would increase the demand of logistics services. To reach the potential of CLSs, they should be designed as part of the planning process though allowing for flexibility to adopt during the production phase of the project (Janné, 2020).

A policy implication is that the municipalities in their role as public developers should continue their ongoing activities of demanding CLS in projects, as it increases the awareness of construction logistics in the industry and facilitate the advancement in the use of various logistics services. Earlier experiences of requiring logistics plans in London (Transport for London, 2013) and Stockholm (Janné and Fredriksson, 2022) have created a positive attitude towards the use of CLS over time. This policy implication can be transferred to other countries than Sweden, given the benefits that construction logistics can provide, for instance, when tackling traffic congestion in dense urban areas, or improvements of safety on sites, which are contemporary challenges that are not limited to the Swedish context.

Conclusions

The purpose of this paper was to investigate whether construction logistics services are still carried out mostly in an *ad hoc* manner, or has advanced to a more standardized, strategically

implemented practice and to explore different actors' attitudes towards construction logistics. The results of the questionnaire showed that construction logistics services are still carried out *ad hoc*, with only 14% of the responding organizations having a standard CLS within their organization. Though, this may change considering that those respondents who have been employed for a long time in the industry stating that they are experiencing an increased demand for construction logistics in project inquiries during the tendering phase. Based on the number of cases implementing CLS in Sweden, it can be concluded that the Swedish construction industry commonly implement CLSs in projects. However, the results of this study show that this might be the case in prestigious and large projects, and not in an "average project", which, in fact, represent the majority of projects carried out in terms of volume and taken together, project net value on the industry level. According to the results, contractors and large organizations seem to plan logistics better than other types of organizations. In particular, large organizations use multiple services in a CLS. Furthermore, there is in general a more positive attitude towards the effects of construction logistics versus the risks of increased costs. For most of the effects, respondents from an organization with *ad hoc* approach to logistics rated the effects lower. Hence, based on the questionnaire it can be concluded that CLS will be used increasingly in the construction industry, meaning that it will be more common to have standard CLS among organizations and, therefore, implement construction logistics more strategically in house-building construction projects.

Limitations

The study has been limited to the Swedish construction industry and to housebuilding projects only. It has also been limited to developers/clients, contractors, municipalities and consultants actor wise. One of the strengths of the sample is that it covers a wide variety in terms of geographical location, type of project, size of project, actor role, etc. This heterogeneity makes the results more relevant also for other contexts, as there are overlapping features – not on industry level, but in terms of certain conditions. Cross-country comparisons as well as comparisons with organizations working with infrastructure projects might be useful to confirm the results here. Furthermore, the respondents were limited to predefined suggestions of construction logistics services. These services were selected based on their frequency of appearance in earlier literature, of course as logistics services becomes more common in the construction industry, there will be new services to be included to cover the variety of services used. Though, because of the limited use of logistics in the construction industry the present selection of services included should be relevant. Furthermore, the Swedish construction industry has a relatively large off-site production compared to other countries. However, this study has not considered the choice of production method, such as on-site or prefabrication, which have implications in the choice of using different CLSs. This is worth considering while generalizing findings from this study to countries with other production process commonalities.

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Appendix

Table A1. Attitudes towards construction logistics based on different roles

General opinions on construction logistics	Roles							ANOVA test
	CEO	Senior manager	Design related	Production related	Project manager	Facility manager	Purchasing	*p*-value
I believe that there are often requirements for construction logistics in procurement	2.8	2.59	2.87	2.82	2.8	2.41	2.6	0.670
I believe that there are often requirements for construction logistics in implementation	3.46	3.7	3.8	3.91	3.71	3.33	3.69	0.457
I am experiencing an increased demand for construction logistics in projects	3.72	3.77	3.67	4.07	3.95	3.7	4.03	0.408
I experience requirements for construction logistics in projects as a risk of increased costs	3.21	3.38	3.26	3.33	3.21	2.83	3.49	0.771
I experience requirements for construction logistics in projects as an opportunity for reduced costs	4.65	4.47	4.58	4.49	4.31	3.87	4.12	0.196
"Construction logistics solutions…"								
Reduce the number of transports to the construction site	4.73	4.24	4.46	4.35	4.52	3.85	4.13	0.082
Reduce the number of man-hours for craftsmen on the construction site	4.36	4.24	4.4	4.34	4.26	3.5	4.18	0.307
Leads to a more efficient use of resources in the form of crane, elevator and lull at the construction site	4.84	4.52	4.76	4.92	4.68	4.21	4.42	0.104
Reduce disruption to surrounding businesses	4.28	4.53	4.61	4.51	4.63	4.5	3.88	0.051
Increase safety at the construction site	4.76	4.39	4.89	4.65	4.71	4.35	4.27	0.137
Increase security around the construction site	4.64	4.51	4.85	4.71	4.7	4.55	4.18	0.230
Increase delivery precision to the construction site	4.85	4.49	4.78	4.72	4.7	4.47	4.42	0.554

Source: Authors' own creation