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Organising construction logistics: A case of network re-orientation

Competitive paper

by

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Abstract

This paper explores the reorientation of ConSite Logistics, a firm specializing in logistics operations at construction sites. The general aim of the paper is to analyze the prerequisites and consequences of an actor's reorientation efforts in a business network. The specific aim is to investigate the reorientation of ConSite Logistics, with regard to on-site and off-site logistics operations. The analysis is based on generic changes in the three network layers: reconfiguration of activities, recombining of resources and repositioning of actors. The empirical material was collected during a time period of 5 years and concerned ConSite Logistics, their operations, and the features of parts of their supply network context. A total number of 26 interviews were conducted with representatives of 12 organizations.

The paper shows how the effects of the reorientation depend on the conditions of individual actors, the business relationships in which they are involved, and the ability to adapt to new conditions. The arrangements organized by ConSite Logistics provide considerable advantages for on-site logistics. However, some off-site operations are hampered by the features of on-site organizing. These negative effects arise because the new arrangements require adaptations in the supply network, which interfere with the established logic of standardisation in the industry.

Keywords: reorientation, construction, logistics, network

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A DYNAMIC NETWORK ACTOR

This paper explores the reorientation of a firm engaged in logistics operations. This firm – ConSite Logistics (henceforth referred to as CSL) – specializes in materials handling at construction sites. Initially, the founder of the firm was involved in transportation of building materials from a wholesaler's warehouse to construction sites in the western part of Sweden. At one occasion, a customer asked for materials to be delivered to the exact location at the site where the materials were going to be assembled in the building. This request differed from normal procedures where materials were unloaded at an assigned storage area on site. CSL's founder recognized the novel approach as a potential business opportunity and established a new firm focusing on 'inbound transportation of building materials'. CSL was started, under another name, as a traditional building merchant, but delivered materials to sites in a more structured logistical manner than other distributors. The firm was unique in having personnel with competences in both transportation and construction, as well as experience in supply of materials.

The major differentiation in comparison with 'traditional' distribution was that materials were transported to assembly points at sites, instead of being delivered to storage areas. This approach made materials handling on site more efficient. The next step of the reorientation with the ambition to enhance efficiency was to deliver building materials after regular working hours, which substantially reduced disturbances with the assembly activities at the site. These arrangements attracted considerable interest from building contractors and the firm became increasingly focused on inbound logistics and materials handling, 'rather than just selling building materials'. The demand for the extended logistics services at sites grew and soon became the main business of the firm. To make this change visible, the firm adopted the name CSL. After some years, CSL decided to focus totally on materials handling at sites, with no involvement in selling or transportation of materials. Consequently, the building merchant business was disposed of. Instead, the operations of CSL evolved to encompass consultancy work, including logistics analysis and the development of a web portal for delivery planning.

MOTIVES, AIMS AND OUTLINE OF THE PAPER

CSL began as a transporter of building materials, got established as a building materials distributor with particular focus on site logistics, became totally concentrated on materials handling on site, and evolved into a consultant in construction logistics. These dynamics make the CSL case a relevant study object from both a practical and a theoretical perspective.

From a practical point of view, previous research has shown that logistics represent a substantial share of total costs in construction. Wegelius-Lehtonen (2001) reported that the logistics costs for supply of plasterboards accounted for 27% of the purchasing price. They also found that 60% of logistics costs were related to the operations at site, including, for example, unloading, internal transportation of materials to and from storage areas, and further movement to the point where they were going to be used. These operations were not only drivers of cost, they also caused other problems. For example, Agapio et al. (1998: 131) concluded that the supply of building materials to site "is fraught with obstacles, which can have a significant effect on levels of productivity". Such effects occur because building materials require large storage capacity that is not always easily available. Furthermore, materials handling at sites have shown to cause damages when materials are moved, as well as through the influence of weather conditions (Ying et al., 2014).

Construction firms have strived to solve these problems. One of the measures applied has been to outsource materials handling to specialized subcontractors. Lindén and Josephson (2013) found that outsourcing reduced logistics costs by around 20%. However, Fang and Ng (2011) concluded that there are still few studies that have analysed the consequences of such reorganization. In particular, the potential role of intermediary organizations, like building merchants, seems to have been overlooked (Vidalikis et al., 2011). Over time, building contractors have increasingly turned to third-party logistics providers (3PLs) in order to introduce supply chain management thinking in construction (Ekeskär et al., 2014). The authors found that such modifications represented a new phenomenon for both contractors and 3PLs. On this basis they concluded that "there is a need to explore how this new phenomenon impacts the productivity of construction projects in general and the performance of the construction supply chain in particular" (ibid. p. 2). This study explores the role and effects of a logistics service provider involved in such operations.

The analysis of the changing role of CSL is based on concepts from industrial network theory, as portrayed in Håkansson and Snehota (1995). This approach was suggested as a relevant framing for further research of third-party logistics in two reviews of logistics outsourcing (Selviriadis and Spring, 2007; Marasco, 2008). This means that from a theoretical angle the study provides insights in the dynamic reorientation of a network actor. Any actor is constantly involved in reorientation, because of changing conditions, ambitions to create a more beneficial situation for the company, and responses to similar attempts from other actors. Therefore, the framework required for the analysis of the changes of the logistics service provider also contributes to the framing of network dynamics. Our framework takes its starting point in the ARA-model (activities, resources, actors), as presented in, for example, Håkansson and Snehota (1995) and Håkansson et al. (2009).

Consequently, the general aim of the study is to explore prerequisites and consequences of a network actor's reorientation in the three layers of activities, resources and actors. The specific aim is to investigate the reorientation of CSL's on-site logistics organizing.

In the next section we describe the context in which CSL operates and the changes that were under way and supported their reorientation. This is followed by the framing of the research phenomenon. After this section, the research methodology is presented followed by the empirics of the study. Then the empirical information is analysed with concepts derived in the analytical framework. The paper ends with conclusions and implications.

LOGISTICS SERVICES AT CONSTRUCTION SITES

The utilization of logistics service providers has been an important means of improving logistics and supply chain performance in other industries than construction (Maloni and Carter, 2006). Potential benefits of the exploitation of the resources of 3PLs were demonstrated by, for example, Bowersox (1990), Bhatnagar and Viswanathan (2000) and Haldorsson and Skjoett-Larsen (2004). The construction industry in general has been found to be lagging behind in terms of supply chain practices and efficiency and therefore facing problems in managing logistics and supply chains (Briscoe and Dainty, 2005; Segerstedt and Olofsson, 2010). However, examples indicate that benefits for construction can be attained through increased attention to logistical issues. For example, Lindén and Josephson (2013) found that outsourcing to specialized 3PLs led to enhanced performance in accordance with suggestions in the literature, in terms of: (i) reducing the risk of not having material available where it is needed in due time; (ii) reducing the risk of damage to materials during transportation at site, as well as during storage; and (iii) reducing the movements of people and equipment during assembly.

Ying et al. (2014: 262) claimed that a successful construction project "heavily depends on the coordination of the on-site and external logistics". One of the reasons for problems in this respect was "a lack of planning of material deliveries and unloading among subcontractors and their site workforce (ibid. p. 269). Since there were no formal procedures for purchasing, staff had to deal with different formulas for ordering materials in relation to the various suppliers. In a similar vein, Agapio et al. (1998: 136) blamed purchasing principles for problems caused by the chasing for lowest possible procurement price, "without careful consideration of the costs associated with handling and production at site".

Ying et al. (2014) found that suppliers rarely gave feedback whether or not they would be able to deliver requested materials. Thunberg and Persson (2013) confirmed the poor delivery services by concluding that less than 40% of supply was delivered with the right volumes, at the right time and location, damage free and appropriately documented. Ying et al. (2014) reported also that materials often were delivered to site with as little as ten minutes of notice, which caused major disturbances and waste of time. Site managers had to organize ad hoc teams to offload materials which created scheduling conflicts and inefficient unloading.

The magnitude of these problems is illustrated by some figures. Vrijhoef and Koskela (2000) estimated the total handling and logistics costs in construction to be as high as 250% of the materials purchasing price. Strandberg and Josephson (2005) found that construction workers spent 15% of their working time moving materials and equipment to the assembly area. Josephson and Saukkoriipi (2005) concluded that waste in the construction industry amounted to 30-35% of production costs. They observed also a low level of utilization of the machinery at sites. None of these resources was used more than 50% of the working time. This means that lots of work at a construction site is undertaken manually, illustrated by the fact that 'transportation by hand' represented 43% of the logistics costs at sites (Wegelius-Lehtonen, 2001).

Obviously, there is potential for improvements of on-site operations in construction. Dubois and Gadde (2002) concluded that prevailing arrangements implied substantial interaction between firms engaged at sites to adapt standardized resources to specific site conditions. They argued for increasing interaction with manufacturers of building materials to improve site performance through customized solutions. In a similar vein, The Swedish Construction Federation estimated that enhanced efficiency in transport and logistics could potentially reduce costs by 20% (SBI, 2010). Sobotka and Czarnigowska (2005) argued that any actions towards rationalization of the size, structure and organization of materials utilization and consumption would increase project efficiency. In particular, they emphasized the role of proper planning of delivery and storage. The European Construction Institute concluded that materials delivery to site is a critical, productivity-related aspect which demands the introduction of a carefully developed system of monitoring and control (ECI, 1994). Agapio et al. (1998: 136) argued that the introduction of such effective materials flow control processes requires the coordinated action of numerous parties performing a variety of functions. Such logistics approaches involve a new role for materials suppliers, including "overall responsibility for the flow of information relating to materials". In a similar vein, Vidalikis et al. (2011: 223) advocated a central role for distributors of building materials "as main coordinators of the logistics activities". These prevailing conditions indicated a window of opportunities for a logistics actor like CSL.

ANALYTICAL FRAMEWORK

The transformation of CSL from being a provider of transport to become a building materials distributor towards a consultant and site logistics specialist exemplifies network reorientation. Analyzing the prerequisites and consequences of such a change calls for investigation of modifications in the three network layers. Gadde at al. (2010) labelled these types of changes: reconfiguration of activities, recombining of resources and repositioning of actors. Any actor with ambitions to re-orientate by, for example, modification of its service offering, must consider all three types of changes. The discussion below is entirely based on concepts from Håkansson et al. (2009) and Gadde et al. (2010) unless other references are mentioned.

Reconfiguring in the pattern of activities

In the activity layer an actor may be able to re-orientate by taking over a specific activity from another actor. This may happen because the change agent can undertake the activity more efficiently, for example, by conducting the activity at larger scale than the established actor. Another option would be to conduct the activity in a different way, for example, by substituting personal interaction with various types of information technology – a common theme in many distribution networks. A third way would be to change the coordination among activities. Typical examples concern the increasing integration of activities required for just-in-time deliveries (JIT) and build-to-order manufacturing (BTO). Finally, a firm may enable reorientation in the activity layer by changing the scope of its operations. One way would be to reduce the scope by focusing on fewer activities, while another one would be to broaden the scope by expanding the bundle of activities.

The central issue in the activity layer regards modifications of the division of labour among actors. Such changes are to a large extent contingent on the economies of scale on which activities are undertaken. Specialization is one obvious way to improve the efficiency of activities, since this approach increases the scale of the operations. At the same time the conditions for learning and knowledge expansion are improved through this enhanced focus.

One significant aspect of activity coordination regards the connections between serially related activities – i.e. when one activity must be finished before the next one can be started. These conditions are typical in supply chains and can be analysed through the level of 'complementarity' (Richardson, 1972). Complementary activities thus have to be undertaken in a specific order. Furthermore, two activities may be 'closely complementary' through their joint interdependence. Close complementarity occurs when two activities are so highly adjusted in relation to one another to improve their joint performance that they cannot easily be linked to other activities. These conditions are prevalent in strongly integrated activity chains like JIT and BTO.

Reorientation in the activity layer involves reconfiguration of the established activity structure. Significant attributes of such reconfiguration concern changes in the economies of scale, the forms of coordination, and the interdependencies among activities. All these issues are related to the level of complementarity between the activities.

Recombining in the constellation of resources

In the resource layer, reorientation may be based on more effective exploitation of available network resources. Such exploitation is related to improvements of the economies of scale in the activity layer. For example, logistics resources like airports and logistics hubs can be used more effectively through increasing scale of the operations. In the analysis of the economies of operations, another concept from Richardson (1972) can be used: similarity. Two activities are similar when they utilize one and the same resource. By increasing the similarity of activities, actors thus are economizing on their resource utilization.

Reorientation may also be rooted in improvements attained by bringing in new resources. Such resources may be physical, for example in terms of new vehicles or materials handling equipment. They may also involve non-physical resources such as planning systems and other skills and capabilities that improve the conditions for resource utilization.

One significant aspect of reorientation in the resource layer regards the adaptations of resources. The joint effect of two resources can always be improved by adaptations that impact their interfaces, but such benefits are accompanied by disadvantages: the better two resources fit together, the more difficult it will be to use them effectively in relation to other resources.

The above conditions make resource combining and recombining central issues for reorientation in the resource layer. In these efforts, an actor's control of the resources is fundamental. Control can be achieved in two ways. Direct resource control is attained through ownership. Indirect control, on the other hand, is achieved through access to the resources of other actors. Over time, indirect resource control has become increasingly important. The expansion of knowledge and technologies made it impossible for a single actor to rely on ownership control for all resources critical to its operations. Therefore, firms are increasingly engaged in relationships with other businesses in order to access their resources.

For the reorientation in the resource layer, recombining of resources is critical. In these efforts the access to the resources of others are important supplements to the resources controlled through ownership. One significant aspect of recombining is concerned with changes in the adaptations and interfaces between resources. Another aspect relates to the benefits achieved from improved resource utilization through increasing similarity among activities.

Repositioning in the web of actors

Reconfiguring of activities and recombining of resources impact on the position in the web of actors. Repositioning may occur by replacing another actor through enhanced performance in the activity and resource layers. Such improvements may result from internal capabilities and skills of the actor, and/or through the connections to the competences accessed through others. These effects occur through changes in the structure of the connections in the network.

Another dimension of repositioning regards the features of these actor connections, i.e. the nature of the business relationships. These features are modified by changes in the involvement between actors, through increasing and decreasing the degree of collaboration. Relationship involvement is affected by the level of coordination between the activities of the two parties, as well as by the interfaces between the resources they combine. Increasing involvement improves conditions for the joint performance of two actors and builds on extended relationship interaction.

Interaction and involvement are beneficial to efficiency and effectiveness in a relationship. At the same time, however, interaction and involvement in terms of adjustments and adaptations are resource-demanding. Therefore, repositioning through modification of these issues in relation to business partners must be monitored and evaluated with regard to what benefits and sacrifices they represent – expressed as relationship benefits and relationship costs.

Moreover, extended involvement increases the interdependence among actors. In many situations interdependence is asymmetric, which makes one of the actors more dependent on the other than vice versa. With regard to behavioural concepts such situations provide the less dependent actor with power over the other. Power is one important aspect of what is identified as the 'relationship atmosphere' in the IMP vocabulary. Other dimensions of this atmosphere are issues related to confrontation, such as conflict and control, as well as cooperative aspects like trust and commitment.

For any repositioning in the web of actors, business relationships are central. An actor aiming at changing its position may find that task difficult owing to high involvement and strong bonds between the other actors. On the other hand, the existing relationships of the actual change agent may be very useful in this reorientation. Finally, repositioning will always be accompanied with changes of the relationship structure in the web of actors. Reorientation through repositioning puts the emphasis on changes of the business relationships in the network. These changes deal with both establishing new relationships and dissolution of existing ones. Other aspects regard the modification of the level of involvement and interaction patterns, which in turn are related to the relationship atmosphere.

Research issues

Above we analysed important aspects in the three network layers when it comes to a specific actor's ambition for reorientation in a network. Below we summarize the important issues derived in the analysis of the network layers that needs to be scrutinized in research efforts aiming at exploring prerequisites and consequences of reorientation in networks:

Reconfiguring in the activity layer may occur through:
- Activities taken over from other actors through changes in the division of labour
- Activities undertaken in new ways, implying modifications of activity configurations
- Changes in the scope of activities through specialization
- Changes in the coordination of activities

Recombining in the resource layer may occur through:
- Exploiting existing resources more effectively
- Provision of new resources that impact established resource combinations
- Changes of the interfaces between resources through adaptations
- Modifications of the means of resource control

Repositioning in the actor layer may occur through:
- Replacing another actor through enhanced performance in the activity and resource layers
- Changes in the network connections among business relationships
- Changes in the level of involvement with individual business partners
- Modifications in the interaction patterns and the relationship atmosphere.

RESEARCH METHODOLOGY

As indicated above, current arrangements in construction logistics tend to involve increasingly complex configurations. These features call for holistic perspectives on the research phenomenon, favouring a case-study approach that "investigates a contemporary phenomenon in its real-life context" (Yin, 1984: 25). Furthermore, Eisenhardt (1989: 534) argued that “the case study is a research strategy which focuses on understanding the dynamics within single settings”. This approach was found appropriate for the current investigation of an actor’s dynamic repositioning in its specific network context.

As pointed out in the analytical framework, the study is rooted in the industrial network approach with its three main layers: activities, resources and actors. This research framing directed the study and the data collection. According to Halinen and Törnroos (2005) a case study approach is suitable for studies relying on industrial network theory since this methodology allows for an understanding of the dynamics of a contemporary phenomenon, which is hard to separate from its context. The authors identified some key issues that need to be approached when conducting case studies. Below we discuss how this case study has been conducted with regard to three of these issues.

Firstly, *‘delimiting the case network’* was done by first focusing on one firm, CSL, and their on-site activities. From this setting, the ‘off-site network’ was derived by tracing the off-site effects that were related to the novel on-site organizing of construction logistics. The search for consequences of the on-site organizing identified a variety of effects, both on-site and off-site, in the three network layers and for various types of actors (e.g. distributors, transportation firms, contractors, and material manufacturers).

Secondly, in order to *‘master network complexity’*, Halinen and Törnroos (2005) claimed that “contacts to several informants that have good access to the studied issues and the case network, as well as close and direct relationships between researchers and practitioners, are needed” (ibid. p.1290). On this basis we collected data from various types of actors in the network, all with their unique perspectives on the organizing of construction logistics. A total number of 26 interviews were conducted with representatives of 12 organisations (Table 1). In addition, information concerning CSL and their operations was collected from several previous studies focusing on this firm and its operations

Companies	**Number of interviews**
CSL	14
4 Contractors	4
2 Subcontractors	2
2 Distributors	3
1 Project management consultancy firm	1
1 Material manufacturer	1
1 Transportation firm	1

Table 1. Interviews in the study

Furthermore, six site visits were conducted that provided observations regarding unloading from vehicles and site transportation with pallets and elevators. Furthermore, an intermediary storage facility at a large construction site was visited. In addition, secondary data were collected in terms of, for example, site disposition plans, requests for tender, and resulting tenders. Other useful empirics included CSL’s materials handling directives, and data from their delivery planning systems.

Thirdly, to *‘tackle the dynamics of networks’* we have followed the same firm (CSL) since 2010 in different projects and settings. One of these projects is still ongoing. This engagement, over five years in various contexts, have contributed to enhanced understanding of CSL and its role in construction projects and construction networks.

THE CSL CASE

This section describes CSL's current way of organizing logistics at construction sites. To illustrate the reorientation of the company we compare this arrangement with the form of logistics organization that is normally applied. We label this alternative 'traditional', which is representative also for the operations of CSL before the reorientation. The space allowed for the paper made it impossible to illustrate all steps in CSL's reorientation, and therefore the emphasis is put on the specialisation on on-site logistics. The section begins with some additional information about CSL and continues with descriptions of the main characteristics of the two forms of organizing with regard to both on-site and off-site operations.

About CSL

CSL is hired for logistics organizing by main contractors or subcontractors for house building projects, such as residential properties, public buildings, or refurbishment of existing commercial buildings and public sector buildings like hospitals. Logistics organizing comprises (i) planning of site layout with regard to cranes, elevators, transport routes and storage areas, and (ii) coordination of physical deliveries of vehicles to and from the site. These services are applied in several of the phases of a construction project. In the initial phase of a project this organizing involves the shuttle traffic of demolition materials, transport of shaft and detonation bulk from the site, and filling materials to the site. The second project phase involves organizing of the intensive inbound deliveries of fragile and weather sensitive materials to the many firms involved in the operations at the site. To some extent, CSL is also involved in logistics organizing during the third phase when the construction operations have been completed, and elevators and cranes are removed from the site.

CSL's level of engagement differs among projects. Extensive logistics organizing is mainly provided in larger projects, with challenging logistics conditions, for example owing to exceptionally crowded sites, central city locations or when the operations of a client have to continue, despite ongoing construction activities. Logistics consultancy services may include resource- and materials flow analyses before the project starts, and/or 'complete' logistic responsibility during the project. In the latter situation, CSL locates a team at the construction site. This team commonly consists of a logistics manager, a logistics coordinator, a delivery planner, a person responsible for arrival control, and one or several gate guards.

Materials handling encompasses unloading from vehicles on arrival at the site, visual inspection of goods and transport from unloading area to assembly area. All materials handling takes place after regular working hours by personnel hired by the hour by CSL. For these operations, construction elevators are preferably used, rather than the tower crane that is located at the site. The work force includes a manager and a number of staff corresponding to the size of the operations. CSL's involvement in a project thus varies from 'only' the materials handling operations in certain project phases (accounting for 25% of CSL's business), to a comprehensive logistics responsibility, before and during a project.

Organizing on-site logistics

This section covers CSL's current approach to on-site logistics, followed by a description of the 'traditional' way of organizing these operations.

CSL's approach

A large construction project commonly involves more than 100 000 vehicle deliveries to the site. In order to facilitate the coordination of these deliveries, CSL developed a web portal.

When contractors and subcontractors need materials to be delivered they book a time slot in the web portal, starting from 16:00, as materials handling takes place after regular working hours. Booking has to be made at least five days in advance, including: type of material, type of vehicle, number of goods, and equipment needed to handle the material at the site. The system then approves or denies the request depending on already planned materials handling or other ongoing activities at the site that would interfere with handling operations. The delivery planner from CSL is responsible for organizing logistics with regard to efficient use of cranes, elevators and personnel hired for materials handling. A daily delivery schedule is created based on the planned utilization of cranes, elevators, fork lifts and men hours.

CSL's responsibility for onsite logistics leads to several consequences. Contractors and subcontractors are not allowed to bring in materials to the site since all deliveries must be approved in the web portal. Contractors and subcontractors have to pay CSL a fee, depending on the size and amount of goods, and whether the material is to be placed on pallets or trestles. Building materials must be wrapped in such ways that they can be transported from the unloading area to the assembly area without being split. If the tower crane has to be used, for example for long goods, an extra fee applies. Managers at contractors and subcontractors are responsible for assuring that suppliers of materials fulfil these requirements, including delivery after regular working hours in line with the booking in the web portal. Hence, CSL is not in direct contact with materials manufacturers, wholesalers or other types of suppliers. The agreement regarding deliveries and materials handling is made between CSL and the contractors, which are then responsible for instructing suppliers.

Suppliers' trailers arrive at the site in accordance with the 30 minutes time slot assigned in the web portal. The CSL person responsible for arrival control has to approve appearance to the site gate. This is necessary, since in many cases there is not enough space for trailers to wait close to the gate, or at the unloading area. The main purpose of the arrival control is to check for any visible damage on incoming goods. Almost every delivery has some kind of damage as materials undergo many handling steps: production, packaging, transportation from factory, terminal operations, and transportation to sites. In many cases, there is also a mismatch between the number of pallets registered in the web portal and those actually delivered to the site. CSL documents all damages rigorously to be able to sort out if they have occurred before arrival to the site, or during the materials handling on the site, which is CSL's responsibility.

After unloading and quality checks, materials are transported to the respective assembly area, marked as 'house X, floor Y, coordinates ZW'. To the extent possible, CSL uses pallet lifts and construction elevators to transport the materials from unloading to the assembly area, as this is the most efficient way. These operations require that certain conditions regarding elevators must be fulfilled, concerning dimensions, motors and capacity. Furthermore, the elevator must be aligned to all floors, including the ground floor, so that pallet lifts can be used. If these conditions, or the wrapping instructions regarding incoming goods, are not met, handling time increases, in turn leading to increasing costs.

One of the main benefits of CSL's approach is the undertaking of materials handling after regular working hours. In this way, these activities neither disrupt, nor are disrupted, by building operations. Furthermore, elevators are solely used for materials handling, while in daytime they are utilized for transport of construction workers. In addition, the CSL principles for logistics organizing minimize storage of materials at the site. Materials are directly moved from unloading to the assembly point, implying that construction workers can start with installation work immediately in the morning. Consequently, construction workers are not at all involved in materials handling. As the space for storing is limited in the building, it is not possible to keep large material quantities in storage. Therefore, material delivery is based on a 'just-in-time' principle, with supply for only a few days' work.

The traditional approach
CSL's approach differs considerably from the traditional approach to on-site logistics. When the traditional approach is applied, large volumes of materials normally have to be stored at the site. The underlying reason is the prevailing purchasing principles. Contractors often order materials in bulk to attain volume discounts and reduce the price per unit. The same conditions apply to transportation, which means that deliveries are often planned to minimize transport costs by maximizing the cargo on trailers. Consequently, large volumes of materials tend to arrive at the site long before they are to be installed. Moreover, as the disposition of the site changes, materials have to be 'moved around' at the site. On average, every bundle of materials is moved seven times before installation.

Sites are not suitable for materials storage because of bad weather conditions and lack of space. Moreover, ongoing construction work inevitably causes damages. Some materials, such as gypsum boards, must be stored indoor in a completely dry area as they are very moisture sensitive. Owing to these conditions building material waste in a project is estimated to average 10 %. This means that 10 % is added to the calculated volumes of materials owing to expected damage, loss or theft.

When construction workers are involved in materials handling, they have to alter between these operations and construction work. As mentioned in the literature review, studies show that site transportation accounted for around 15% of a construction worker's daily working hours and that the total time waste amounted at about one third of the daily working hours, including: time spent on searching for materials; unpacking; sorting and separating into suitable bundles; time spent on waiting for materials; and disruption of work flow. In addition, there are often waiting times at elevators as they are heavily utilized for transporting both materials and workers. Waiting time also apply for usage of the tower crane. The crane is a substantial investment and should therefore not be standing unused. However, as the crane can only carry out one operation at the same time, queues cause waiting time and delay operations. In particular, the extensive need of the crane for 'moving around materials' hampers construction operations. Moreover, construction workers are less efficient in materials handling than the specialized staff of CSL. It is estimated that when contractors handle materials on their own, they require two or three times longer time than CSL.

When the traditional approach is applied, contractors have to estimate the time and cost for the various operations at the site. However, materials handling costs are not normally explicitly specified. Contractors often use 'unit times' to calculate costs by internally developed templates, supplemented with the experience of site managers and other people involved in cost estimation. In the competitive tendering processes there is a great pressure to keep costs down. At the same time, it is important not to underestimate costs since the contractor is financially responsible if the project exceeds the budget when the business is based on a fixed price. To a great extent, site mangers and cost estimators tend to be quite unaware of the precise costs related to materials handling, wherefore materials handling costs are included in a schematic way based on unit times and costs.

In comparison, when CSL is used, the costs for logistics and materials handling become explicit as they appear on the tender. As a fee is paid by contractors for each unit of goods handled by CSL, it is crucial for contractors to take this cost into account in the tendering processes. Also, as a result of the requirement to book deliveries at least five days in advance to avoid extra goods at the site, managers must plan more rigorously to match work operations with the need of materials. These conditions require close interaction among managers and construction workers with regard to updates of time plans and the progress of other operations at the site. It is most crucial that construction workers are not lacking any materials as such conditions will delay the project. The 'just-in-time' principle for delivering materials also requires contractors to be specific with their suppliers regarding call-offs of materials, packaging instructions and delivery times. Before the first delivery to the site, CSL and the contractor meet to make sure that these requirements can be fulfilled.

Even though the contract between CSL and the subcontractors clearly stipulates the logistics demands and the prices for materials handling, conflicts tend to arise concerning these conditions. All subcontractors need to comply with the demands, but not all agree that this is an efficient solution for materials handling.

Organizing off-site logistics

This section first describes off-site logistics organizing as it is carried out when CSL is involved, followed by an account for the 'traditional' way of organizing.

CSL's approach

When CSL is hired for on-site logistics organizing, the off-site operations of material manufacturers, distributors and transportation firms are impacted considerably. In these projects the role of CSL is clearly stated in the tendering process, which means that all contractors involved in the project are informed already from start. In practice, this implies that the main contractor and all subcontractors must use CSL for all logistics operations on-site. Before the first delivery to a site, each contractor needs to participate in an introduction event arranged by CSL concerning the logistics concepts and activities in the project, as well as the requirements imposed. Contractors, in turn, need to inform their partners in the project about the delivery procedures. For example, tenders from material manufacturers must include specific details regarding type of material, packaging, pallet handling, quality assurances and logistics details, including precise delivery times, number of deliveries and principles for unloading at the site. This detailed level of tenders differs from the common standard in the industry. Therefore, material manufacturers often respond with a direct purchase price, which means that the tender must go back and forth several times before all requirements have been met.

For manufacturers these requirements cause extra work and thus additional costs. For example, window manufacturers normally bundle windows according to the logic of their production flows. However, the demands from CSL require windows to be packed in accordance with the logic of the materials handling activities at the construction site: packed to enable stacking on pallets handled via pallet lifts and elevators. In addition, CSL requires all materials to be wrapped as one package that is placed on a pallet to avoid damage. Moreover, CSL refuses to unwrap bundles, if they exceed the maximum size. These demands force window manufacturers to re-pack their products before delivery to a 'CSL-site'.

In some situations, intermediate storages must be established off-site, since materials cannot be stored on-site. In one of the projects studied, a distributor together with its transport carrier, set up an intermediate storage facility some miles from a large construction site. At this location, materials were repacked in line with CSL's requirements and then kept in storage, awaiting deliveries after regular working hours. In this case, several site contractors facing the same situation used this distributor, implying that the same setup could be applied to a number of business partners. Therefore, the distributor could use its standard procedures for deliveries from their central warehouse to the intermediate storage facility. The 'last-mile' delivery to the construction site was made by the local carrier in accordance with the time slots booked in CSL's web portal.

Some projects require adapted solutions regarding site deliveries, owing to the client's ongoing operations. For example, in the refurbishment of a large hospital a so called 'check-point' had to be established in close geographical proximity to the construction site. This arrangement assured that by no means should health care operations, including ambulance traffic, be jeopardized by building materials deliveries. Accordingly, all deliveries must pass through this check-point for approval and then continue to the site gate. In addition to this delivery arrangement, some material suppliers run daily 'milk rounds' with minor deliveries to the check-point at daytime. These materials are kept in intermediate storage in containers dedicated to individual contractors at the check-point until they are delivered to the site.

The traditional approach

Central aspects of the traditional approach were indicated in the text above. All in all, CSL's approach is contrasted with the situation where contractors often rely on a materials supplier. In the traditional approach deliveries occur at daytime and material storage at sites is the norm. These arrangements represent industry standard and most suppliers and carriers have adapted their routines and operations in accordance with these procedures. When the traditional approach is used, contractors and materials suppliers plan and arrange for the delivery to the site. Their ambitions are often to minimize transport costs through large scale operations, as storage at site is not perceived as a problem.

Furthermore, in the traditional setting, the packaging of materials is primarily considered from the perspective of the material manufacturer and the logic of the production operations. Normally, there is no need to comply with particular requirements regarding the activities at sites. Therefore, only limited coordination is needed between firms, implying that they can work rather independently as long as they fulfil the basic requirements concerning delivery and packaging.

ANALYSIS

Reconfiguring of activities

The traditional way of organizing results in a scattered activity structure on sites as construction workers constantly move between tasks in accordance with pre-planned work flows, and adjustments to current conditions on site. Accordingly, workers alter between materials handling activities and building activities such as installation and assembly. As a result, materials handling activities are seldom undertaken in well-structured sequences and managers spend a lot of time on coordination to prioritize among the various tasks, including coping with the many deviations from plans. To make this process as efficient as possible, the site manager interacts with materials suppliers in relation to planning and continuous updates of plans. This coordination is troublesome and time consuming.

Moreover, the division of labour among the actors is modified owing to CSL's establishment, implying that construction workers are no longer involved in materials handling. In this way, CSL has 'taken over' this activity from the contractor and this transition includes changes with regard to the scheduling of activities. Consequently, there is an increased integration among the following activities: delivery to site – materials handling – installation. This leads to increased complementarity among activities in comparison with the traditional approach. In addition, materials handling activities are undertaken in new ways by using CSL's staff and relying on elevators rather than the tower crane. These changes improve materials handling efficiency through increasing activity similarity, and reduce overall man-hours.

Construction workers specialize in building operations in the case when CSL is used for materials handling. As a result, building operations performance increases since construction workers do not have to interrupt their work to move materials on site from one storage location to another, since materials are delivered directly to the assembly point.

The CSL approach requires more extensive coordination between subcontractors and materials suppliers to manage delivery at precise times and to specify materials packages. This coordination involves increased planning through the web portal to assure efficient use of resources on site. Managers on site and CSL interact intensely to ensure that the conditions for materials handling are met. Thus, activity specialization needs to be supplemented with enhanced coordination beforehand, to assure efficient materials handlings and to avoid delays stemming from lack of materials for installation. Moreover, activity reconfiguration was illustrated by the deliveries to the construction site at the hospital. Instead of the normal process with direct transport from the central warehouse to the site, the transport was split into two activities: one delivery to the intermediate storage and one delivery from this facility to the site. This separation of the transport activities enabled repacking of materials in accordance with CSL's demands.

Table 2 summarizes the most significant features of the two approaches to on-site logistics with regard to the dimensions of the activity layer derived in the analytical framework. The differences between the traditional approach and CSL's organizing illustrate the main aspects of the reorientation in the configuration of activities.

	'Traditional' approach	**CSL's approach**
Division of labour	Contractors undertake materials handling.	Matrials handling through ConSite Logistics
Activity configuration	Materials handling and building operations conducted by construction workers during day time	Building activities conducted in daytime by construction workers. Material handling in evenings by CSL staff
Scale and scope of activities	Low similarity because of multi-task operations	Higher similarity owing to activity specialization
Activity coordination	Coordination of materials handling and building operations on the basis of specific site conditions	Pre-planned coordination that is extended to involve also packaging and deliveries of materials to sites

Table 2. Central features of activities in the two approaches to organizing on-site logistics

Recombining of resources

Resource combining according to the traditional approach involves many resources that are simultaneously needed for materials handling and building operations: e.g. construction workers, elevators and cranes. This approach to on-site organizing implies low utilization of the capacity of materials handling resources. Because elevators must to a great extent transport workers, the tower crane is used for materials handling, which takes longer time and also results in operations ‘queuing up’ for crane capacity.

When the traditional approach is applied it is the standardized interfaces among the resources at sites that enable them to be combined in various ways and for many purposes. Moreover, decisions regarding the combining of resources on site are to a great extent the result of the experience of site managers and other personnel that has been gained from previous projects. Such knowledge represents important skills for resource combining, which is a challenging task, since numerous resources are utilized on the site simultaneously, often with overlapping needs. Resource combining efforts are mainly directed by standard agreements on types of material, quantities and delivery times, although the features of resources are related. The standardized interfaces between resources lead to limited interaction among the firms involved in buying and selling of building materials. In turn, substantial adaptations of resources are needed on the site to combine these materials to fit with the specific requirements of particular construction sites.

The utilization of on-site resources is improved when CSL undertakes materials handling after regular working hours. During day time elevators can be used exclusively for transport of construction workers, while CSL exploits the elevators in the evening. Also the utilization of the tower crane is improved since it can be used solely for building operations.

The adapted interfaces among resources such as pallet lifts, elevators and materials packages enable CSL to organize on-site materials handling in an efficient way. CSL also brings in its own specialized personnel, with knowledge and experience from carrying out materials handling operations in many projects. In the same way, the conditions for resource utilization on site are improved by CSL’s web portal as a planning device for deliveries to the site and utilization of materials handling equipment. Hence, more efficient exploitation of network resources at the site is achieved when on-site logistics organizing is carried out by CSL.

At the same time, however, the requirements for adapted deliveries of building materials hamper efficient utilization of resources off-site. Building materials are normally bundled in packages that fit the conditions of factory production. Thus, adaptations of material packages in line with the conditions on a specific site make them function less well in their produce context in the factories. Hence, it is important that material manufacturers agree to make these packaging adaptations. Otherwise these adaptations need to be handled in other ways as illustrated by intermediate storage facility of the transportation firm. Adaptations of manufacturers reduce the similarity of their operations and leads to decreasing economies of scale since these features do not fit with other customers’ requirements regarding packaging. Thus, in certain situations other resources are indirectly affected by adaptations made between building materials and site resources used in CSL’s materials handling.

In one of CSL’s projects, two new resources were established as a direct consequence of their approach. The facility for intermediate storage was introduced by a distributor in order to handle the requirements on on-site logistics. This facility represented adaptation of the distributor’s established logistics and transportation set-up. The storage was utilized by several subcontractors implying that costs could be shared. This example illustrates an off-site adaptation as a direct consequence of CSL's approach to on-site logistics organizing. The adaptations in the resource constellation improved the resource interfaces from the logic of CSL's approach, but created additional costs for subcontractors. Another new resource was the 'check-point' that was established in the same project. This resource interacted tightly with the trucks arriving at the site and also other resources, such as containers for storage.

In 'traditional' materials handling all rented resources that are needed on site are under a sort of 'ownership control' of the contractor during the project. Utilization of resources is planned by the contractor in interaction with materials suppliers to coordinate deliveries to the site. Potential benefits of specialization are difficult to attain because the equipment is needed simultaneously for materials handling and building operations. These multiple demands result in waste of resource capacity for moving around materials and for switching between the various operations.

Using CSL for on-site logistics organizing represents reorientation in the resource layer. By engaging CSL, contractors are provided with access to CSL's skills, knowledge and routines, including resources in the form of personnel and the web portal. As a result, increased interaction is needed between contractors and materials suppliers to secure the resource adaptations needed for CSL's materials handling activities. This interaction between contractors and materials suppliers is directly dependent on the interaction between the main contractor and CSL. Requirements related to adaptations of resources are critical for CSL to ensure that materials handling can be carried out in the same way at many sites. In this way, CSL exploits the available site equipment for their materials handling activities. It would not be economically feasible for CSL to control these resources through ownership. Hence, CSL is dependent on access to these on-site resources provided by the contractor.

Table 3 summarizes the most significant features of the two approaches to on-site logistics with regard to the dimensions of the resource layer derived in the analytical framework. The differences between the traditional approach and CSL's organizing illustrate the main aspects of the reorientation in the configuration of activities.

	'Traditional' approach	**CSL's approach**
Resource exploitation	Inefficient utilization of tower crane, elevators and construction workers.	Enhanced efficiency through increasing specialization in the utilization of resources.
Resource combining logic	Established principles for combining of handling equipment and skills of construction workers.	Established principles supplemented with advanced information systems and skills of specialized staff
Resource interfaces	Standardized interfaces that are adapted to specific site conditions by subcontractors and construction workers.	Resource interfaces become adapted before building materials are delivered to construction sites
Type of resource control	Direct control through ownership of resources	Indirect control through the access to others' resources

Table 3. Central features of resources in the two approaches to organizing on-site logistics

Repositioning of actors

The two sections above, dealing with reconfiguring of activities and recombining of resources, illuminate certain implications for the actor layer – and thus for the issue of repositioning. CSL's replacing of contractors in materials handling operations was enabled through CSL's ability to provide enhanced performance in the activity and resource layers with regard to on-site logistics operations. This repositioning was based on CSL's capabilities and skills built up over time through increased experience in on-site logistics organizing, and the emphasis on standardized materials handling activities and resource exploitation at many sites. Enhanced performance in building operations stemmed from the specialization of construction workers, which no longer have to alter between materials handling and building operations. This implies that the reorientation of CSL involved the taking over of on-site logistics activities from contractors and undertaking them in new ways, by introducing new resources and also exploiting existing resources in a more efficient way. The scope of activities performed by the various actors thus changed as did the coordination of activities. In addition, the reorientation also involved changing interfaces among resources through adaptations. This repositioning applies to both on-site and off-site operations.

All in all, these changes created challenges as well as opportunities for the actors in the network since established network connections were affected. The use of CSL introduced new relationships into the existing network and impacted the established relationships. For example, the relationships between subcontractors were extended since they needed to interact more. This interaction promoted knowledge transfer among subcontractors concerning assembly tasks, which positively impacted on installation and the end-product.

Moreover, the study showed how relationships between the subcontractors and their distributors changed due to the new organizing. In general, the use of CSL and the increasing demands for planning and coordination led to closer relationships and increasing involvement between distributors and subcontractors.

As was illustrated in the analyses of reconfiguring and recombining, CSL's organizing principle created effects both on-site and off-site. These consequences were perceived differently by the various actors in the network, since they affected the interaction patterns and the relationship atmosphere. For example, some subcontractors found this solution cost efficient while others found it to be costly. These divergences related to how these actors calculated the costs for logistics and transportation. As a result, in some situation the demands of CSL create tensions and potential conflicts in the relationships with some of the subcontractors, the contractor and their transportation partners. In most cases these conflicts can be solved in a constructive way by communication and interaction within the frame of the existing relationship. However, sometimes this approach is not sufficient and in one project CSL needed to use other control mechanisms to make subcontractors comply with the logistics requirements. CSL had to apply its contractual control, stemming from the contract signed by the contractor and all subcontractors to follow the requirements set by CSL. In lack of direct authoritative control, CSL mobilized the client to use its formal power to direct the activities of contractor and subcontractors to comply with the logistics principles. However, this way of using authoritative control can have negativel impact on trust and commitment in the relationship atmosphere.

Table 4 summarizes the findings concerning repositioning in the actor layer in the dimensions derived in the analytical framework.

Repositioning dimension	Impact of CSL's organizing of on-site logistics
Replacing another actor through enhanced performance	CSL improved the efficiency in the activity layer through increasing specialization of configurations. These changes built on the provision of new skills and resources, leading to modifications of established resource combining principles
Changes in the network connections among business relationships	CSL's approach is based on adapted building materials, requiring coordination of the whole network from materials manufacturers via distributors and CSL to installation staff
Changes in the involvement with individual business partners	CSL is deeply involved with contractors and subcontractors. In turn, these actors feature increasing involvement in relation to each other, as well as to materials suppliers.
Modifications of interaction patterns and relationship atmosphere	Increasing involvement requires more intense interaction, in turn impacting the relationship atmosphere. Some actors benefit from CSL's organizing. For others this organizing create tensions and thus a negative relationship atmosphere

Table 4 Re-orientation through repositioning in the actor layer

CONCLUSIONS

The specific aim of this study was to investigate CSL's re-orientation of construction site logistics. The above analysis showed that both materials handling, undertaken by CSL after regular working hours, and building operations, carried out by construction workers during day time, were improved through reconfiguring of activities and recombining of resources. In order to provide for these enhancements, contractors and subcontractors at sites had to adapt to CSL's materials handling principles, requiring increased planning beforehand, and increased interaction with suppliers to assure that these requirements were met. The new conditions were perceived differently by various actors: some contractors saw it as a great advantage to work in this way, whereas for other contractors the new arrangement was more problematic, and even disadvantageous. Hence, the effects of the reorientation depends to a great extent on the conditions of individual actors and their willingness and ability to adapt to the new conditions.

Moreover, the analysis showed that while positive effects were achieved on-site, off-site logistics organizing was hampered by the new arrangement. Material manufacturers, distributors and other suppliers had to undertake adaptations that reduced the efficiency of their operations in terms of packaging, delivery, and storage operations. These consequences represent extra costs as adaptations impede on the ability to benefit from economies of scale in the exploitation of resources. In addition, new resources had to be introduced, for example, the intermediate storage – an investment made solely for the actors involved in one of the projects. To a great extent, the construction industry builds on the logic of standardization in the supply network, which, in turn, requires substantial adjustments at construction sites. Therefore, if all contractors would pose individually adapted requirements of materials, the efficiency in supply operations would be significantly reduced as a whole, since the scale of the operations would be reduced. Thus, as adaptations might create certain benefits they also come with a cost, and have to be balanced with the ability to provide for economies of scale.

On the general level, the study explored central re-orientation issues when a new actor is entering an existing network. In such occasions, new relationships with associated interaction patterns have to be developed by the entrant and established network actors. When these features become manifest they indirectly impact on other actors and their relationships. Repositioning among actors is enabled through improvements in the activity and resource layers. Enhanced performance in these respects can be achieved through increasing specialization of the activity scope of individual actors and refined utilization of resources. Such specialization requires increasing coordination of activities and fine-tuned combining of resources across corporate borders to secure the functioning of entire activity configurations and resource constellations.

However, any attempt to provide benefits in some dimensions inevitably impacts on other dimensions as well. Increasing involvement among actors is most often associated with ambitions related to customization and individualization. Such adaptations are costly and tend to reduce the scale of the operations. Therefore, potential benefits have to be evaluated with regard to their costs in order to assure that advantages are not outweighed by accompanying disadvantages. Finally, any re-orientation is beneficial to actors in some part of the network, whereas other actors may feel threatened by the same changes. Such consequences must be taken into consideration in the networking actions of the re-orientating actor.

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