



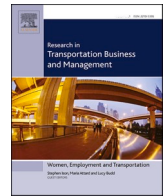
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Citation for the original published paper (version of record):

Hagberg, J., Hulthén, K. (2022). Consolidation through resourcing in last-mile logistics. *Research in Transportation Business and Management*, In Press. <http://dx.doi.org/10.1016/j.rtbm.2022.100834>

N.B. When citing this work, cite the original published paper.



Consolidation through resourcing in last-mile logistics

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ARTICLE INFO

Keywords:

Retailing
Last-mile
Logistics
Distribution
Consolidation
Transport
Resourcing

ABSTRACT

This paper assesses how various ways of organizing last-mile logistics impact resource utilization, and, in turn, opportunities for consolidating goods. The paper combines a conceptualization of resourcing and consolidation derived from the literature with an analysis of contemporary last-mile logistics options in the Swedish retail market. Based on the analysis of three forms of last-mile logistics—consumer logistics, retailer logistics, and hybrid logistics—the paper discusses how resourcing for fixed, mobile, and coordination resources can enable consolidation in terms of time, place, and form. Drawing from the Swedish context, the paper calls for additional research combining country-specific studies while examining similarities and differences in last-mile logistics, particularly concerning factors that enable or hinder consolidation as well as how such potentials are realized in practice. Although consolidation clearly appears in the rich literature on last-mile logistics, this paper focuses on how consolidation can be achieved through resourcing and offers additional insights into current frameworks for last-mile logistics in retailing.

1. Introduction

This paper focuses on resourcing and consolidation in last-mile logistics in retailing. In retailing, last-mile logistics (Lim, Jin, & Srail, 2018), or ‘last-mile delivery’ (Lim & Winkenbach, 2019), ‘last-mile distribution’ (Hübner, Kuhn, & Wollenburg, 2016), or simply ‘the last mile’ (Edwards, McKinnon, & Cullinane, 2010), concerns closing the gap between points of acquisition and points of consumption. The paper conceives last-mile logistics as encompassing activities performed by retailers, consumers, and other providers and including both online and traditional store-based retailing. Thus, last-mile logistics is defined as the last stretch of business–consumer logistics, which spans the point of an item’s assignment, no matter where (e.g., in store or at a fulfillment center), to a unique consumer until the point of consumption—in our case, the consumer’s home.

Last-mile logistics not only accounts for a large share of total costs in supply chains (Hübner et al., 2016) but also heavily influences their impact on sustainability (Browne et al., 2008; McKinnon & Woodburn, 1994; Pålsson, Pettersson, & Winslott Hiselius, 2017). Although last-mile logistics activities today continue to be overwhelmingly performed by consumers themselves, often by use of their private cars (Hagberg & Holmberg, 2017; Rai, Mommens, Verlinde, & Macharis, 2019), recent developments in online and omni-channel retailing have

made actors other than consumers (e.g., retailers and third-party transport and logistics providers) responsible for logistics activities, including transport. In turn, those developments have spurred the introduction of new business models for last-mile logistics (Hübner et al., 2016; Morganti, Seidel, Blanquart, Dablanc, & Lenz, 2014).

In recent years, an emerging stream of research has involved analyzing aspects of last-mile logistics, typically in frameworks that can double as guides for describing the variety of last-mile logistics options and their effects. Hübner et al. (2016), for instance, developed a framework of modes of last-mile deliveries, including varieties of home and ‘click-and-collect’ delivery. More recently, Lim et al. (2018) identified three major forms of last-mile logistics options—push-centric, pull-centric, and hybrid systems—and their structural and contingency-related factors. Lim and Winkenbach (2019), by comparison, developed a typology of four forms of last-mile supply networks that differ in their delivery responsiveness and product variety. Most recently, and along similar lines, Halldórsson and Wehner (2020) distinguished six last-mile options according to their energy efficiency: conventional shopping, click-and-collect, collect at pickup points, collect at lockers, home delivery, and in-car delivery.

To make sense of such research, Olsson, Hellström, and Pålsson (2019) systematically reviewed literature on last-mile logistics and identified five interrelated components therein: last-mile logistics, last-

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mile distribution, last-mile fulfillment, last-mile transport, and last-mile delivery. They also classified the various facets of those components into five themes: emerging trends and technologies, operational optimization, supply chain structures, performance measurement, and policy. Among those facets, consolidation contributes to multiple themes, including operational optimization (Estrada & Roca-Riu, 2017; Lin, Chen, & Kawamura, 2016; Zhang, Sun, Hu, & Zhao, 2019), supply chain structures (Paddeu, 2017; Veličković, Stojanović, Nikolić, & Maslarić, 2018), and policy (Aljohani & Thompson, 2019).

Although consolidation has indeed surfaced as an important feature of last-mile logistics and may provide several benefits for costs, environmental impact, and customers' convenience, there is a paucity of studies that explore where such consolidation is possible within the various approaches to organizing last-mile logistics. Different ways of organizing last-mile logistics, however, may provide diverse opportunities for utilizing resources and, in turn, enabling various forms of consolidation.

Against this backdrop, this paper assesses how the various ways of organizing last-mile logistics in retailing impact resource utilization and opportunities for consolidating goods. For a starting point, the paper reviews recent literature on last-mile logistics in retailing and on major forms of consolidation, which we define in line with Vaillancourt (2016, p. 3) as a topic "generally understood in the business literature as combining certain activities or materials that have common attributes." We also introduce the notion of resourcing as an approach to studying resources and resource utilization (Feldman, 2004; Jahre, Gadde, Håkansson, Harrison, & Persson, 2006) and argue that resourcing imposes conditions on how consolidation can be achieved. Building on that research, we base our paper on a study of current ways of organizing last-mile transport in retailing in Sweden. Our study of last-mile logistics options derives from three categories identified by Lim et al. (2018), albeit with two adaptations. The first concerns the terminology; instead of push-centric systems, pull-centric systems, and hybrid systems, we use the terms retailer logistics, consumer logistics, and hybrid logistics as it indicates who is responsible for organizing the last mile logistics activities. The second adaptation concerns the specific variants of last-mile logistics identified in those three categories on the basis of our empirical material. Thus, Lim et al.'s (2018) framework forms the basis for how we have structured the empirical material, which with some adaptations consequently forms the basis for how we identified opportunities for consolidation enabled by resourcing.

The paper accounts for traditional and emerging forms of organizing last-mile logistics in connection with online and omni-channel retailing, including purchases in traditional stores, home delivery, and collection points. It also serves as an empirically grounded basis for exploring how resource utilization through resourcing in different forms of last-mile logistics may enable improved consolidation. Thus, combining the theoretical foundations with our empirical basis, we analyzed how ways of organizing last-mile logistics in retailing impact resource utilization and consequently enable the consolidation of goods to various degrees. Going forward, the results of the analysis form a basis for facilitating more comprehensive analyses of variety in last-mile logistics and its outcomes, thereby providing useful input for practitioners and researchers.

2. Consolidation and resourcing in last-mile logistics

In this section we account for the theoretical foundations on the basis of previous literature on consolidation and resourcing, especially considering their applicability in last-mile logistics.

2.1. Consolidation

According to Vaillancourt (2016, p. 3), consolidation is "generally understood in the business literature as combining certain activities or materials that have common attributes." Consolidating goods, a major

way for firms to reduce costs (Cooper, 1984), has been discussed in numerous contexts, including inventory consolidation (i.e., consolidating goods at central stocking points; Mahmoud, 1992), market consolidation (i.e., firms merge to create synergies from assets and operations; Gong, Zhen, Yin, & Wu, 2016), purchasing consolidation (i.e., firms concentrate their sourcing to few suppliers; Trent & Monczka, 1998), transportation consolidation (i.e., smaller deliveries are consolidated in single loads for increased transport efficiency; Çetinkaya, 2005), and consolidation of retail deliveries (McKinnon & Woodburn, 1994). Most recently, Montecinos, Ouhimmou, Chauhan, Paquet, and Gharbi (2020) have discussed how a logistics platform for sharing 'less-than-truckloads' could increase transport efficiency in urban settings.

In logistics, consolidation among shippers, i.e., the buyers of transport services, and transport service providers (TSPs) has topped many firms' agendas due to heightened pressure to use resources in transport and logistics systems more efficiently. Outsourcing logistics and transport services to TSPs relies on the idea that TSPs consolidate goods from many shippers and can thereby use resources more efficiently than each individual shipper (Abbasi, Saboury, & Jabalameli, 2021; Yang, 2015). Recent research on consolidation in last-mile logistics has, in particular, addressed urban consolidation centers (UCCs) (e.g., Anand, van Duin, & Tavasszy, 2021; Hezarkhani, Slikker, & Van Woensel, 2019; Isa, Lima, & Vidal Vieira, 2021).

DeHayes Jr. and Taylor (1974) argued that logistics concerns creating utility in place and time. Relating to consolidation this means identifying and exploiting 'common attributes' in these dimensions. Hence, consolidation of place refers to finding similarities in relation to geography (e.g., distance, proximity, and population density) and setting (e.g., layout of stores, shopping centers, consumers' premises, and pickup points). Furthermore, the opportunities for consolidation of place also relate to the choices of mode of transport since various modes have differences in reach and carrying capacity. For example, if goods are directed to a congested city center, a cargo bike or a small electric distribution van might be more appropriate than a heavy truck. In a similar line, consolidation of time relates to finding similarities with regard to availability, delivery time, and frequency and precision of delivery. Though the utility of form has been regarded as belonging to the domain of production (Fawcett & Fawcett, 1995), Emerson and Grimm (1996) argued that dimensions of form are crucial aspects in logistics and they thus add the dimension of form to those of time and place as utilities created in logistics. For one, the consolidation of form considers the exploitation of common attributes in the inherent characteristics of goods (e.g., size, weight, dimensions, degree of hazard, and temperature requirements), their packaging (e.g., variety of materials, size, and degree of standardization), and their potential combination with other goods (e.g., in assortments and in logistics and transport resources). Hence, all three dimensions capture various aspects of consolidation in last-mile logistics. Considering those dimensions, some actors may group products according to one or several of them and thereby establish a basis for consolidation.

Consolidation is closely linked to resource utilization. For example, consolidating multiple items in a box instead of packing each item individually may increase fill rates in transport. In a similar way, consolidating similar packages together—for instance, plastic bags with other plastic bags and cardboard boxes with other cardboard boxes—may improve material handling operations at distribution centers or pickup points. Added to that, consolidating goods from several retailers in one shipment for a TSP creates the potential to increase resource utilization by raising trucks' fill rates. Viewing capacity as a distinct resource, Wehner (2020, p. 46), in discussing the importance of utilizing capacity, has argued that because "distribution in the last mile is exceptionally energy-intensive due to low fill rates, the use of private vehicles and the vast number of stops, that leg of supply chains shows exceptional potential for improving energy efficiency." In that effort, consolidating goods should be a key concern, and Wehner (2020, p. 73)

has thus stressed that “future research should focus on logistics fulfilment in the last mile given its potential for different distribution options.” In response to that call for research, this paper concentrates on resource utilization via consolidation in various last-mile logistics arrangements.

2.2. Resourcing

Any type of consolidation requires resources and is thereby related to resource utilization. In last-mile logistics, consolidation can involve various types of resources—for instance, vehicles, distribution centers, pickup points, shop facilities, consumer homes, time-schedules, people, information systems, and packaging—each having unique features (in terms of time, form and place), which, in turn, can be exploited in consolidation. An important underlying theoretical point of departure in this paper is resource heterogeneity, implying that the value of a resource is not to be regarded as given since it depends on how it is used and combined with other resources (Jahre et al., 2006). For firms involved in last-mile logistics, it is therefore imperative to identify resource features that enable potentials for consolidation in time, place, and form. This consolidation occurs when resources are combined. We refer to that process of resource combination as resourcing (Feldman, 2004; Jahre et al., 2006).

Hence, following Jahre et al. (2006, p. 22), this paper takes its starting point from the perspective that “resources are always combined with each other” and that each resource’s logistical attribute is determined by how it interacts with and is adapted to other resources, such that, for example, a transport package’s size impacts any transport vehicle’s utilization of capacity. In turn, when resources are combined, new features of resources may be discovered and utilized. Considering that resources have hidden features, Jahre et al. (2006, p. 20) also argued that efficiency, in terms of the utilization of individual resources, in logistics is “largely a question of combining resources – physical and organizational,” driven by the effort of “finding better ways of utilizing all the available resources.” Dubbing “the processes involved in the changes to resource constellations and the utilization of resources” as resourcing, Jahre et al. (2006, p. 21) indicated that resource utilization depends on that dynamic, interactive process of combining resources.

By comparison, Feldman (2004) recommended focusing more on utilizing resources than on the actual features of resources themselves. That notion of resourcing suggests a definition of resources focused on how firms identify and use resources as they pursue activities in line with what they wish to perform or accomplish. Later, Feldman and Worline (2011) described resourcing as it would pertain to a rock. In their thinking, objects have inherent features (e.g., a rock is heavy) that give them potential as resources (e.g., a rock can be used as construction material). Resourcing thus implies that an object is not a resource until its features have been activated for some purpose and, in turn, some form of utility has been created—for example, a rock is not a resource until it is used in construction. Until such use occurs, the object is merely a potential resource, and not before that use can its type as a resource be determined.

Taken together, literature on the topic suggests similar interpretations of resourcing, especially in light of the dynamic aspects of resources and the interplay of and mutual adjustments to multiple resources. The notion that resources ‘become’ when used for a specific purpose points in a similar direction; a resource doesn’t have a pre-determined use or value, but the value is determined by how the resource is de facto used and combined with other resources. On that basis, we regard resourcing as what creates the potential to consolidate time, place, and form by discovering the features of resources that can be exploited to allow consolidation.

Considering all of the above, this paper seeks to identify how last-mile logistics options enable the kind of resourcing that makes the consolidation of time, form, and place possible. In our analysis, we differentiate fixed resources, mobile resources, and coordination

resources. We define fixed resources as resources, usually facilities, that are stationary—for instance, stores, pickup points, logistics terminals, consumer homes, delivery boxes, post office boxes, and mailboxes. By contrast, mobile resources are resources that connect fixed resources to each other—for instance, modes of transport, vehicles, and postal workers. Last, coordination resources coordinate the mobile and fixed resources—for instance, information systems (e.g., track-and-trace systems), delivery schedules, route planning systems, and actors’ planning capabilities.

3. Method and materials

This paper combines a conceptualization developed in light of the literature with a study of contemporary last-mile logistics options in Sweden (see Table 1). The study involved a search of last-mile logistics options provided by major retailers in Sweden, including online retailers. The sample of retailers was compiled by combining a list of 40 high-revenue retailers in Sweden (Market, 2018) with another list of 30 online retailers with high domestic revenue (E-handel, 2018). Of those 70 retailers, six were duplicates—two appeared on both lists, and four were listed multiple times due to their organizational form—which left a final sample of 64 companies. In that sample, we combined major retailers with major online retailers for four reasons. First, retailing in physical stores currently dominates in Sweden, meaning that major retailers should be included even if their online sales are modest. Second, several major retailers in Sweden do not publicly report their online domestic sales separately from their total sales or online sales abroad, meaning that they did not appear on the list of online retailers but should nevertheless be included in our sample. Third, to provide variety for our analysis, it was important to include major online retailers, several of which offer nontraditional last-mile delivery options. Fourth and finally, by including both major retailers and online retailers, we could capture the omni-channel aspect—that is, the combination of physical and online stores.

For the data collection, conducted in 2018, we browsed the websites of all 64 retailers on the list and, in most cases, completed part of the online purchasing process to identify what kind(s) of delivery options the retailer offered. Next, we developed a matrix compiling all of the retailers’ names, delivery options, major product categories, and number of stores. In our initial analysis, each delivery option represented the specific last-mile option provided (e.g., attended final destination deliveries or attended external pickup points) and the actor performing transport (e.g., the retailer or a specific TSP). Last, and partly following Lim et al. (2018), we grouped the options into three generic forms of last-mile logistics options along with variations in each category. As shown in Table 1, at the time of the study there was a high dominance of acquisition in store, attended final destination deliveries and attended external pickup points, while the unattended fixed delivery points and

Table 1
Types of last-mile logistics among the studied retailers.

Generic type	Specific form	No. of delivery options	No. of retailers
Consumer logistics	Acquisition in store	44	44
	Attended final destination deliveries	9	48
Retailer logistics	Unattended final destination deliveries	3	22
	Attended internal pickup points	29	29
	Attended external pickup points	8	47
Hybrid logistics	Unattended fixed delivery points	1	4
	Unattended roaming delivery points	1	2

roaming delivery points were quite rare.

Two interviews with representatives of one of the major TSPs in Sweden were conducted. A first interview was held with the Head of Sustainability to discuss major trends in the retail sector in relation to last-mile logistics and the TSP's roles and challenges with regard to this. A second interview was held with the Senior E-commerce advisor discussing primarily last-mile logistics with a focus on E-commerce. Furthermore, in order to catch the perspectives of pick-up points a study visit was made to a newly started pick-up point. An interview with the CEO of the pick-up point was also held focusing on the main challenges and opportunities in last-mile logistics from the perspective of a pick-up point. We also discussed our preliminary results with 12 experts—retailers, urban planners, logistic service providers, and logistic consultants—at a workshop. The workshop relied on so called back-casting where the participants were confronted by some future scenarios of 'sustainable last-mile logistics' and the discussion then focused on these future scenarios and how to get there. The various perspectives on this topic from the participants contributed with new insights for our understanding of the material.

Added to that, reports issued by the Swedish Competition Authority (*Konkurrensverket*, 2016) and the Swedish government agency *Trafikanalys* (2020) provided complementary information and also verified some of our own observations. The report by the Swedish Competition Authority discussed the current situation concerning parcel deliveries and home-deliveries of grocery in Sweden. The report by *Trafikanalys* discussed the current situation in Sweden concerning transport involved in e-commerce and how this kind of transport can become more efficient and sustainable. In both these reports various aspects of time, place and form dimensions were brought up, as well as different aspects of potential for consolidation, even if not phrased exactly in those terms. This altogether, provided additional and complementing input to our understanding of the material.

The research process can be said to be abductive (*Dubois & Gadde*, 2002), where we successively combined and matched data from the various data sources with a conceptual elaboration of the notions of resourcing and consolidation. The data collection of last-mile options from retailer websites showed a large variety of set-ups involving different types of resources. This indicated that various resources, their multifaceted natures, and how resources are combined is an important issue in last-mile logistics. Furthermore, the interviews, observations, the workshop and additional information from different reports also confirmed this. Furthermore, during this phase of the process, the notion of consolidation came to the fore, as a way to discuss how resources are utilized and matched together. In relation to this process also resourcing, the matching process when resources are combined, and the various dimensions of time, place and form, emerged as central theoretical concepts. Hence, our analysis of dimensions of consolidation and various types of resources was eventually extended with reference to literature on consolidation and resourcing, which helped us to grasp how the multifaceted nature of resources impacts the potential for consolidation. All in all, the conceptual framework, the data collection, and the analysis developed in parallel, but in interaction, during the whole research process.

4. Consolidation in three generic types of last-mile logistics in retailing

We observed both conformity and variation in the 251 delivery options offered by the 64 retailers that we analyzed, for an average of 3.9 options per retailer. To conceptualize the different types of delivery, we considered who (i.e., generic type of actor) performed last-mile logistics, and in that dataset (see *Table 1*), we identified three generic types of last-mile logistics (cf. *Lim et al.*, 2018). The first was *consumer logistics*, in which the consumer organizes the last-mile logistics both concerning transport and consolidation. The second category was *retailer logistics*, in which the retailer organizes last-mile logistics both in terms of

transportation and consolidation. The third category was *hybrid logistics*, in which the retailer organizes the first part of last-mile logistics, while the consumer organizes the last part. *Fig. 1* illustrates the three generic types of last-mile logistics and their sub-categories.

4.1. Consumer logistics

In consumer logistics, an item is assigned to a specific consumer in a physical store at the point of acquisition. That type of last-mile logistics was labeled *acquisition in store*, in which a consumer buys a product in a physical store and transports it to the point of consumption. As a category of last-mile logistics, consumer logistics thus encompasses all situations in which consumers pick items 'off the shelf' and purchase them in physical stores. From that point, transport activities are performed by consumers, who are also responsible for potential consolidation during transport, as is the case when multiple goods are acquired during the same shopping event from the same retailer (e.g., a consumer buys a week's worth of groceries at one store during the same trip instead of shopping for groceries every day), thereby generating a consolidation of form. Although such consolidation depends on the availability of goods at the single store, its potential increases when purchases are made at several retail stores located near each other (e.g., in shopping centers and shopping streets) or along a route where the consumer may visit different stores, which also implies the potential for the consolidation of place. In turn, that potential depends on stores' opening hours in order to allow for the consolidation of time.

In consumer logistics, because consumers are responsible for transport and consolidation, they are also responsible for resource utilization. However, the potential and need for consolidation vary among modes of transport concerning, for example, carrying capacity or environmental impact. For instance, from an environmental perspective, when a consumer uses a private combustion engine car for transport, the need for consolidation is greater than when transport means walking, biking, or using public transport, because such a car's environmental impact is usually higher than the others. The potential for the consolidation of form is also greater with a private car than with the others, because cars allow traveling greater distances than walking, for example, which enables the improved consolidation of place. Furthermore, compared with public transport, a car does not require adjusting personal schedules and, in many situations, may take less time than public transport—except during traffic jams in urban areas—which enables the consolidation of time. Last, cars can accommodate more goods than bicycles can without any special arrangement, which allows for the consolidation of form.

To illustrate, we present two situations in consumer logistics: one involving consolidation and another that does not. In the first, the consumer purchases a single item from a store, and no consolidation with other items occurs. In the second, the consumer consolidates the item bought in the focal store with another item from that store and two additional items from two other stores: one near the focal store (e.g., in the same shopping center), the other farther away (e.g., en route to the final destination). Thus, the second situation allows consolidations of time, place and form, thereby enabling a potential reduction in transport. Consequently, two situations of consumer logistics appear—one involving consolidation, the other not—even though consolidation relates only to items assigned to the specific consumer. Between those situations, various cases involve acquiring single or multiple items from single or multiple retail stores during the same shopping event.

4.2. Retailer logistics

In retailer logistics, an item is assigned to a specific consumer and delivered to the final destination (e.g., the consumer's home). The retailer organizes the transport, either in cooperation with a TSP or via its own or subcontractor's system. The retailer or TSP performs all transport activities from the point where the item is assigned to a

Point where an item is assigned to a consumer

Point of final destination

LAST-MILE LOGISTICS

CONSUMER LOGISTICS

Acquisition in store



RETAILER LOGISTICS

Unattended final destination delivery



Attended final destination delivery



HYBRID LOGISTICS

Attended internal pickup point



Attended external pickup point



Unattended fixed delivery point



Unattended roaming delivery point



Fig. 1. Illustration of three types of last-mile logistics.

specific consumer (e.g., a fulfillment center, distribution center, or manufacturing plant) to the final destination. We can distinguish two subcategories in retailer logistics: *attended final destination delivery*, which requires the presence of a consumer or proxy at the destination,

and *unattended final destination delivery*, which involves delivery to a mailbox or drop-off at the ‘doorstep’ of the destination.

Attended and unattended final destination deliveries offer different possibilities for consolidation depending on two factors. First, the

consumer's demands and options for delivery time (i.e., time from order to delivery) and delivery precision (i.e., exact time or time window for delivery) impose restrictions upon the consolidation of time. Unless strict restrictions exist concerning delivery time and delivery precision, then place can be more easily consolidated—for example, by directing many items to the same geographical area. In that way, the consolidation of time creates opportunities for increasing the utilization of transport resources. For those reasons, the degree to which time and place can be consolidated is pivotal for efficient resource utilization in last-mile logistics.

Second, different items have different characteristics of form. In particular, different kinds of transportation packaging (e.g., by size and shape), as well as requirements for temperature and safety (e.g., for hazardous goods), set restrictions for the consolidation of goods by form. Deliveries to mailboxes, for instance, are restricted by the size of mailboxes and the width of mail slots. Some unattended final destination deliveries even involve leaving goods in so-called 'inside homes' or refrigerators that can be accessed with a time-limited code during a certain time window.

Attended deliveries may provide additional opportunities for the consolidation of form insofar as they allow many different types of goods to be delivered at once. However, to consolidate time and place across multiple deliveries can also pose additional challenges for coordination—for example, requiring all deliveries to be performed when authorized persons are present to receive them. For unattended deliveries, such coordination is less critical, because their time windows may be less strict since nobody needs to be present to receive the deliveries in person. Nevertheless, in those cases, other challenges arise concerning the consolidation of form related to the character of the goods (e.g., required temperature and value) that make them unable to be left in a mailbox or on the 'doorstep'.

As implied thus far, the retailer or TSP is responsible for consolidating items in retailer logistics. If involved, then a TSP often works on the behalf of various retailers and can consolidate goods from all of them. If the retailer performs deliveries themselves or via subcontractors, by contrast, then the possibilities for all three types of consolidation shift and usually narrow, for they typically only consolidate goods related to a single retailer.

4.3. Hybrid logistics

In hybrid logistics, an item is assigned to a consumer, delivered to a pickup point, and retrieved by the consumer, who organizes its transport to the final destination (e.g., their home). A TSP or retailer performs all transport activities from the point of the item's assignment (e.g., in a fulfillment center, distribution center, or manufacturing plant) to the determined pickup point. When performed by retailers, those activities are typically conducted via attended internal pickup points (i.e., collection in store). However, TSPs can also organize those deliveries, typically by using attended external pickup points, although unattended fixed or roaming delivery points are occasionally used instead.

Hybrid logistics has four major variants. The first two involve attended pickup points: either an internal pickup point managed by the retailer or an external one managed by a third party (e.g., a grocery store, service station, or kiosk). The first subcategory was the *attended internal pickup point*, usually meaning collection in store. The second subcategory was *attended external pickup point*, in which a TSP delivers the product to a collection service provider (CSP); there, the consumer retrieves the product and organizes its transport to the point of consumption. For internal pickup, a TSP or the retailer performs transport from the store or a distribution center to the pickup point; for external pickup, by contrast, a TSP performs the transport. In those variants, opportunities for consolidation are similar to those available with consumer logistics, insofar as the consumer is responsible for creating possibilities for consolidating form, time, and place. Such possibilities often depend on the point of acquisition and the way in which various

points are combined along the same shopping route. Other factors include store opening hours, which are often longer at external pickup points such as service stations and convenience stores than at internal ones in specialty shops (e.g., fashion boutiques), and whether the characteristics of the goods allow for such consolidation (e.g., lack specific temperature requirements or come in volumes that are easily stored).

The third and fourth variants involve unattended pickup points. In the third subcategory, *unattended fixed delivery point*, the product is delivered by a TSP or the retailer to, for example, a delivery box exclusive to a single TSP or open to several TSPs made available for use by multiple retailers and consumers for delivery. Last, in the fourth subcategory, *unattended roaming delivery point*, a retailer or a TSP delivers the product to a non-fixed delivery point (e.g., a car). Both situations enable the consolidation of place, because multiple items can be gathered at the same location. Regarding the consolidation of time, the first variant depends on details about where the delivery box is located (e.g., opening hours of the premises), whereas the second depends on coordinating the times when the car is in the assigned place. Both variants may allow for the consolidation of form insofar as multiple items are acquired simultaneously; however, that possibility may be restricted by the characteristics of the goods (e.g., temperature requirements and size).

Thus, in hybrid logistics, either the retailer or TSP is responsible for consolidating items during transport to the pickup point, and that responsibility can vary according to delivery distance and delivery precision. As in retailer logistics, the consumer's demands and options for delivery time (i.e., time from order to delivery) and delivery precision (i.e., exact time or time window) impose restrictions upon the possibility of consolidating items with other items during the first leg of transport. In turn, strict demands on short delivery times and narrow time windows limit the potential for consolidating time and place, which can curtail resource utilization in transport and thereby lead to lower fill rates). However, the less rigid the restrictions on delivery time and delivery precision, the more opportunities for consolidating place and time—for example, when many items are directed to consumers in the same geographical area.

As the variants of hybrid logistics suggest, the characteristics of pickup points alter the possibility for consolidation. For consumers, consolidating goods from multiple shopping events may be possible with transport if goods are sent to the same pickup point. Most often, however, TSPs use exclusive pickup points, meaning that a certain grocery store, for example, acting as a pickup point collaborates with only one or a few TSPs. As a consequence, consolidation from the consumer's perspective is limited, and the consumer needs to retrieve goods at various pickup points. Furthermore, the pickup points used—grocery stores, service stations, and kiosks, for instance—are seldom designed primarily to act as such. Problems posed by packaging thus hinder those actors when storage is involved, which can restrict opportunities for consolidating form. Furthermore, the ways in which goods are packed (e.g., in cardboard boxes or plastic bags) also impact the handling of goods at the pickup points, which can be especially problematic for external pickup points that receive an array of types of goods from different retailers. Concerning internal pickup points, the goods and packaging may differ depending on the assortment carried by the retailer. Because fashion retailers, for example, may carry only one brand, the goods handled are likely similar in form and packaging, for they arrive from the same fulfillment center. However, when the assortment is diverse and arrives from different fulfillment centers, then the heterogeneity of packaging and the nature of goods may be as challenging as for external pickup points. Furthermore, when a relatively large number of goods needs to be consolidated during a limited period—in Sweden, major instances include the days before Christmas and Black Friday—the actual volume may become problematic due to limitations in the size of the pickup points' facilities.

In hybrid logistics, consumers are responsible for the last leg of

transport—that is, from the pickup point to the point of consumption. For consumers, consolidation in the transport of goods can occur, for example, when fetching goods at a pickup point in conjunction with shopping for groceries and jointly transporting those items to the point of consumption, which enables the consolidation of time, place, and form. Moreover, retailers may or may not offer consumers a choice of TSPs and pickup points. From the perspective of consolidation, the possibility of choosing pickup points may increase the possibility of consolidating goods in the last leg, especially concerning place. However, consumers also face the trouble of packaging. When the last leg is performed by private car, packaging is seldom problematic. By contrast, when walking, biking, or using buses or trams, unnecessarily large parcels can be problematic from the consumer’s perspective if packaging cannot be disposed of at the pickup point.

5. Resourcing as potential for consolidation in various last-mile logistics setups

Across the three generic types of last-mile logistics, three types of consolidation were identified. First, the consolidation of form can occur when goods correspond to each other in their characteristics, packaging, and combinability, both with other goods in assortments in stores and with logistics and transport resources. Second, the consolidation of place can occur when goods correspond to each other in their geographical destination and mode of transport. Last, the consolidation of time can occur depending on the time, precision, availability, and frequency of delivery.

Considering the three categories of last-mile logistics and the three types of consolidation, the question remains concerning how the last-mile options enable resourcing that allows such consolidation. As outlined above, resourcing is a dynamic, interactive process that enables the identification of resources and their features in light of their potential use and how they may be combined. Table 2 summarizes the potential and conditions for consolidation and the resources activated in the various last-mile logistics options considered from the three types of consolidation. The potential refers to the main opportunities for achieving consolidation. The conditions for consolidation refer to what conditions that need to be present for such potentials to be realized. The activated resources are based on our tripartite conceptualization of resources into fixed, mobile and coordination resources outlined above.

From a resourcing perspective, however, those three types of resources should not be regarded as immutable but as adaptable and combinable in novel ways. Moreover, new resources can always be identified and come into use. For example, by using convenience stores as pickup points, new uses of the stores, as fixed resources, can be identified as well. Another example is when resources used for newspaper distribution are used as mobile resources for last-mile logistics. Meanwhile, new resources are also developed to be combined with other resources as a means to create new utilities; examples include various types of delivery boxes combined with existing resources (e.g., stores and shopping malls). By connecting those new resources to other fixed, mobile, and coordination resources, utilities can be created in new ways.

In consumer logistics, the potential for consolidating time relates to the consumers’ freedom to coordinate their time and the possibility for instant access (e.g., availability of goods and store opening hours). The activated resources include fixed such as the stores’ facilities, mobile such as the consumer’s mode of transport, and coordination resources such as the consumer’s ability to coordinate their time. For the consolidation of place, by comparison, the potential for consumers arises in their ability to streamline their travel patterns. To that end, the necessary conditions relate to the geographical position of stores, the proximity of stores, and the distance that needs to be bridged, also depending on the consumer’s mode of transport. As with the consolidation of time, the fixed resources include the stores’ facilities, the mobile resources include the consumer’s modes of transport, and consumers’ ability to determine routes connecting multiple places is an example of a

Table 2
Conditions affecting the potential for consolidation regarding resource use in last-mile logistics.

	Consumer logistics	Retailer logistics	Hybrid logistics
Time	Potential Instant access to goods Consumer’s freedom to coordinate time	Potential Does not require consumer’s time for mobility Retailer may coordinate different deliveries time-wise along the same delivery route	Potential Separate time coordination between retailer and consumer due to buffering function of pickup point
	Conditions Availability Opening hours	Conditions Attended delivery requires coordination of time between retailer and consumer Lead times from order to delivery to final destination	Conditions Limited to opening hours and time window for pickup External and internal pickup points Lead time from order to delivery to pickup point
	Resources <i>Fixed:</i> Store’s facilities <i>Mobile:</i> Consumer’s mode of transport <i>Coordination:</i> Consumer’s coordination of time	Resources <i>Fixed:</i> Facilities at consumer’s home <i>Mobile:</i> Retailer’s mode of transport <i>Coordination:</i> Tracking and tracing systems and delivery notification	Resources <i>Fixed:</i> Pickup point facilities <i>Mobile:</i> Retailer’s and consumer’s modes of transport <i>Coordination:</i> Consumer’s time, tracking and tracing system, and delivery notification
Place	Potential Streamlining of consumer’s travel pattern	Potential Does not require consumer’s transport Combination of transport to several households in the same vicinity	Potential Streamlining of consumer’s travel pattern
	Conditions Position of store Proximity of stores Distance depending on consumer’s mode of transport	Conditions Geographical position of consumer’s home Density of consumers Distance to point of delivery	Conditions Consumer’s ability to choose pickup point Position of pickup point Exclusive or joint pickup points Density of pickup points Number of pickup points per logistics service provider
	Resources <i>Fixed:</i> Store facilities <i>Mobile:</i> Consumer’s mode of transport <i>Coordination:</i> Consumer’s choice of route to possibly connect multiple points	Resources <i>Fixed:</i> Facilities at consumer’s home (e.g., mailbox and lock) <i>Mobile:</i> Retailer’s mode of transport <i>Coordination:</i> Route planning	Resources <i>Fixed:</i> Pickup point facilities <i>Mobile:</i> Retailer’s and consumer’s modes of transport <i>Coordination:</i> Consumer’s route choices to possibly connect multiple points
Form	Potential Acquisition of multiple items in different categories on a single route	Potential Acquisition of multiple items in different categories via a single delivery	Potential Acquisition of multiple items at the same pickup point Alignment of such pickup with regular store visits
	Conditions Mode of transport enables different capacities for consolidation (e.g., loading capacity) Assortment provided	Conditions Characteristics of goods in relation to features of home facilities	Conditions Suitability of goods (e.g., by size and temperature) Packages adapted to different kinds of transport legs and

(continued on next page)

Table 2 (continued)

Consumer logistics	Retailer logistics	Hybrid logistics
by single stores and multiple stores combined		storage (e.g., both retailer's and consumer's transport as well as the pickup point)
Resources <i>Fixed:</i> Assortment <i>Mobile:</i> Consumer's mode of transport and means of carrying goods <i>Coordination:</i> Consumer's combination of various store assortments	Resources <i>Fixed:</i> Consumers' facilities at home <i>Mobile:</i> Retailers' mode of transport and packaging <i>Coordination:</i> Multiple deliveries from the same retailer or several retailers and compatibility of item (s), package(s), and home facilities	Resources <i>Fixed:</i> Pickup point facilities that allow different types of items and combinations <i>Mobile:</i> Retailers' and consumer's mode of transport <i>Coordination:</i> Combination of items from different retailers to the same pickup point

coordination resource. Concerning the consolidation of form, the potential rests in the fact that consumers can acquire multiple items in different categories during a single shopping event, which requires a mode of transport that enables different capacities for consolidation (e.g., sufficient loading capacity) and an assortment of goods provided by single stores and multiple stores combined that enable consolidation. Such assortments are important fixed resources for consolidating form. Beyond that, mobile resources include consumers' modes of transport and various means of carrying goods (e.g., packages and shopping bags). Last, regarding coordination resources, consumers' abilities to combine multi-store assortments are important.

In retailer logistics, the potential to consolidate time depends on retailers' and TSPs' abilities to coordinate different deliveries time-wise along the same delivery route. The necessary conditions include the time coordination for attended deliveries between retailers and consumers, as well as the total lead time from order to delivery to final destination. The fixed resources include the facilities at consumers' homes; retailers' modes of transport are important mobile resources; and coordination resources include information systems (e.g., track-and-trace systems) and delivery notifications. Regarding the consolidation of place, the potential for consumers arises in that they need not transport themselves or the goods; for retailers, it rests in combining transport to make deliveries to several households in the same vicinity. Conditions required for such potential include the geographical position of consumers' homes, the density of consumers in a certain area, and distance to the point of delivery. The resources include fixed (e.g., physical facilities of consumers' homes such as mailboxes and locks), mobile (e.g., retailers' modes of transport), and coordination resources (e.g., systems for planning routes). Last, the potential for consolidating form lies in consumers' abilities to acquire multiple items in different categories in a single delivery. Conditions required are matching characteristics between goods and home facilities—for example, unattended delivery may be unsuitable due to the weather, the equipment available in consumers' homes (e.g., mailboxes), and the item's temperature requirements, value, or size—and fixed resources include consumers' facilities at home. Regarding mobile resources, retailers' modes of transport and packaging matter as well. As for coordination resources, capabilities to organize multiple deliveries from the same retailer or several retailers are important, as is the compatibility of the item(s), package(s), and the home's facilities.

For hybrid logistics, the potential for consolidating time arises from the fact that retailers and consumers coordinate time separately, because pickup points act as a 'buffering function' between the upstream and downstream legs of transport. Conditions shaping the realization of that potential include opening hours and pick up time windows at pickup points and lead times from order to delivery to pickup points.

Fixed resources include pickup point facilities, mobile resources include consumers' modes of transport, and coordination resources include consumers' capabilities to coordinate their time and various track-and-trace and delivery notification systems. Regarding the consolidation of place, potential lies in the possibility of aligning deliveries with consumers' travel patterns. Conditions that determine such consolidation are consumers' ability to choose pickup points, the location and density of pickup points in an area, whether the pickup points are exclusive or shared by TSPs, and the number of pickup points per TSP. Fixed resources include pickup point facilities; mobile resources include retailers' and consumers' modes of transport; and coordination resources include consumers' capabilities in determining routes and the possibility of connecting multiple pickup points. Last, the potential to consolidate form stems from the possibilities of acquiring multiple items at the same pickup point and aligning pick up of items with regular in-store visits. Whether such consolidation is possible depends on, for example, whether the goods are suitable for handling at pickup points, perhaps due to their size or temperature requirements. Whether packages are adapted to different transport legs and types of storage is another important condition, both for retailers' and consumers' transport and for the pickup point. Fixed resources include the pickup point facilities, which, depending on various characteristics, allow for different types of items and combinations of items with other resources. Mobile resources comprise the consumers' modes of transport, while important coordination resources include consumers' capability of combining items from different retailers for retrieval at the same pickup point and combining items from the pickup point.

As shown, we have identified three major types of resources important to achieving consolidation in last-mile logistics and examples of them: fixed resources, including store facilities, pickup point facilities, assortments, and facilities at consumers' homes; mobile resources, including consumers' modes of transportation, consumers' means of carrying goods, retailers' mode of transport, and packaging; and coordination resources, including the connection of multiple deliveries, consumers' choice of route (i.e., to connect multiple points), track-and-trace, delivery notification, and route-planning systems.

Although those three types of resources allow consolidation, they are primarily controlled by individual actors. To generate additional possibilities for consolidation via resourcing, such resources should be increasingly identified, combined, and shared by joint use between actors and actor groups via different forms of collaboration. Such collaboration can be intra-actor (i.e., among actors in the same actor group), inter-actor (i.e., between different groups of actors), and multi-actor (i.e., between several actor groups). First, *intra-actor resourcing* refers to the sharing of resources within actor groups, such as between consumers (e.g., sharing the fixed resources of delivery boxes in a neighborhood, sharing mobile resources by using the same car, and sharing coordination resources by receiving deliveries for the neighbor), between retailers (e.g., sharing fixed resources by serving as pickup points for other retailers, increasingly sharing mobile resources and the resources of TSPs, and coordination resources by virtually combining goods from different retailers to be simultaneously distributed to consumers), and between TSPs and CSPs (e.g., by increasingly sharing fixed resources such as generic pickup points, sharing mobile resources between individual TSPs, and coordinating via joint track-and-trace systems). Second, *inter-actor resourcing* involves sharing various resources between different actor groups (i.e., between retailers, consumers, TSPs, and CSPs). Of course, such collaboration already occurs in several cases, including when different retailers use the same TSP; however, increased collaboration might involve the extension of fixed, mobile, and coordination resources to be more intensely shared. Third, *multi-actor resourcing* may involve several or all of those actor groups and numerous additional actors, including municipalities, property owners, and public transport companies, that focus on sharing fixed resources (e.g., additional pickup points for deliveries), mobile resources (e.g., for passenger transport), and coordination resources (e.g., grids with information

resources that all actors can easily access). Thus, although several resources in the current landscape of last-mile logistics can enable consolidation, opportunities also exist for increasing consolidation by sharing fixed, mobile, and coordination resources in intra-, inter-, and multi-actor resourcing.

6. Conclusions and implications

With this paper, we aimed to assess how the various ways of organizing last-mile logistics impact resource utilization and, in turn, opportunities for consolidating goods. To that end, we analyzed three major forms of last-mile logistics (i.e., consumer, retailer, and hybrid logistics) from the point of how resourcing enables the consolidation of time, place, and form. In turn, the paper provides an analytical framework for identification of potentials for consolidation in last-mile logistics underpinned by the notion of resourcing, especially underscoring the interactive, dynamic process underlying consolidation. The framework, which highlights how new resources can be identified and activated in last-mile logistics and utilized in new combinations, addresses three types of resources: fixed resources (i.e., fixed in place), mobile resources (i.e., move between fixed resources and connect them), and coordination resources (i.e., coordinate the fixed and mobile resources to enable consolidations of time, place and form). Thus, with the framework, new fixed, mobile, and coordination resources can be identified and activated in new combinations that in turn increase potential for consolidation in time, place and form.

In view of the framework, we argue that the potential for consolidation can be enhanced by resourcing that involves increased collaboration within actor groups (i.e., intra-actor), between actor groups (i.e., inter-actor), and among a larger set of actors (i.e., multi-actor), which, in turn, improve the overall workings of last-mile logistics. With the steady growth of online and omni-channel retailing, such collaboration and potential for consolidation have become increasingly important and will likely remain so, if not become even more important in the years to come.

6.1. Implications for research

Although consolidation has continually surfaced in literature on last-mile logistics (e.g., [Abbasi et al., 2021](#); [Olsson et al., 2019](#)), this paper puts consolidation center-stage and analyses where such consolidation is possible and what resources enable it. The paper also introduces and analyzes the notion of resourcing ([Feldman & Worline, 2011](#); [Jahre et al., 2006](#)) in last-mile logistics and identifies three types of resources that facilitate consolidation. Focusing on different types of consolidation and resourcing, it offers additional insights into current frameworks of last-mile logistics in retailing (e.g., [Hübner et al., 2016](#); [Lim et al., 2018](#); [Lim & Winkenbach, 2019](#)).

The three types of resources that we identified follow [Heskett, Glaskowsky, and Ivie \(1964\)](#), who distinguish between two types of resources in logistics: fixed and connecting. Fixed resources, including various facilities, are nodes in the logistics system, while connecting resources, including vehicles, are used to connect the nodes. Our findings suggest that three kinds of resources, as abovementioned, are important for consolidation: fixed resources, mobile resources (cf. connecting resources; [Heskett et al., 1964](#)), and coordination resources, the last of which are key in coordinating fixed and mobile resources in relation to each other and thus pivotal to discovering opportunities for consolidation. Thus, the paper provides a conceptual framework for analyzing the opportunities for consolidation in last-mile logistics by focusing on three kinds of resources that in different combinations provide potential for consolidation in time, place and form.

6.2. Practical implications

The general increase in e-commerce and use of omni-channel

solutions has diversified last-mile options, some of which are based on new types of business models relying on new combinations of resources. The increased number of options enhances the flexibility for consumers regarding those options. However, although that variety and multiplicity has generated significant value for consumers, it has also introduced challenges for consolidation in last-mile logistics, which has important implications for sustainability and efficiency.

The framework can be used as a means for identifying the potential for consolidation and improving consolidation in last-mile logistics via resourcing. By offering a framework for a systematic analysis of various types of resources and their potential contributions for consolidation new resources as well as new resource combinations can be identified, used and exploited, some of which has not even been considered resources in a specific setting yet. For example, in Sweden, when e-commerce developed convenience stores were identified as useful resources in last-mile logistics as pickup points. This fixed resource could be combined with mobile resources (e.g., vehicles used by consumers as well as transport and retail firms) and coordination resources (e.g., information systems) to create potential for increased consolidation. From a consumer perspective, consolidation could occur when picking up e-commerce parcels at the same time as grocery shopping and for firms delivering to the convenience store could mean opportunities for consolidation by co-loading of goods.

Following that, it should be stressed that, similar to [Feldman and Worline's \(2011\)](#) example of the rock, resourcing in last-mile logistics does not necessarily imply the identification and use of completely new or technically advanced resources but is often a matter of identifying, adding, and combining apparently simple ones. For example, consider parcel lockers; they are a fairly simple, mundane technology, installed as a fixed resource in supermarkets, combined with mobile resources in transport to and from them and coordination resources (e.g., information systems) to indicate when goods are available for pick up or have been collected. Taking into consideration that last-mile logistics is under transition, due to the establishment of new (omni-)channels to the consumers and the requirements for short delivery times, it becomes apparent that this area needs to be treated as a dynamic setting not limited to predefined resources. By performing resourcing based on those three types of resources, significant opportunities for consolidation have been created, and similar examples abound of how such consolidation can be achieved in seemingly simple ways.

Another practical implication is to highlight the importance of collaboration within and between actor groups and particularly collaborations that involve multiple private and public actors, including but not limited to retailers, TSPs, CSPs, consumers, municipalities and property owners. Such collaborations may be used in order to identify, combine and share resources for the benefit of increasing potential for consolidation within last mile logistics. The included framework can work as a basis for such collaboration initiatives and also as an aid in the identification and dissemination of good practices. For example, so called horizontal collaboration among firms at the same level in the supply chain has proven to have potential to increase consolidation when firms start to share information about their demand for transport so that TSPs can better coordinate their customers' demands and thereby increase the potential for consolidation.

Finally, as last mile logistics is under development and transformation due to, among other things, changing consumer demands, competition among retailers and changing societal conditions there is a continuous need for innovation and experimentation in order to shape sustainable last mile logistics solutions that adhere to future needs. From the focus on consolidation addressed in this paper, we believe that there is not an inherent contradiction between such innovation and the need for consolidation, but rather that consolidation should be considered as a key aspect in any such innovation aimed at improving last mile logistics in the future.

6.3. Limitations and future research

First, among our research's limitations, the framework was derived from last-mile logistics in retailing in Sweden, which has some characteristics that are not immediately generalizable to other contexts. For example, the grocery retail structure in Sweden relative to other countries is concentrated around only a handful of large retailer associations. Because opportunities for consolidation may differ in geographical markets with less concentration, the need for consolidation would probably be more important. Beyond that, which we have accounted for in this paper, during the growth of online retailing, last-mile logistics in Sweden has involved a relatively high share of hybrid logistics particularly attended external pickup points. Nevertheless, we believe that the framework consisting of various types of resources and the conditions and potentials for different forms of consolidation is applicable also in other contexts.

Again, however, though opportunities for consolidation may differ in other geographical markets with a higher share of retailer logistics involving attended as well as unattended final destination deliveries, pinpointing the potential for increased consolidation may nevertheless become increasingly important. Along those lines, our paper underscores the importance of combining country-specific studies of last-mile logistics that take the specific context into account, ideally in international studies that explore similarities and differences in last-mile logistics and particularly factors that enable or bar consolidation. Moreover, this paper has identified opportunities for consolidation enabled by resourcing and further empirical research is needed to evaluate how such potentials are realized in practice.

Author statement

We hereby declare that the two authors have been involved to an equal degree in all parts of the paper.

Declaration of Competing Interest

None.

Acknowledgements

The paper is part of the research project "Retail shopping and the last mile transport: past, present and future transformations", with financial support from Chalmers University of Technology and the University of Gothenburg.

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