Impacts of Proximity Deliveries on e-Grocery Trips

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This article proposes a discussion of three scenarios related to French e-grocery developments, and identifies and analyzes the effect of new forms of proximity deliveries on household shopping trip flows. One of our objectives will be to consider logistics solutions adopted by online retailers. First, we present the two basic models of B2C: order-picking at a dedicated site and in-store picking. Second, we evaluate three distribution systems adopted by French e-grocery retailers. We focus in particular on the impact of these systems on consumers' purchasing trips and, to this end, we use an empirical simulation approach to make a comparison of the systems studied.

Keywords: e-grocery, warehouse-picking, store-picking, home delivery (HD), out-of-home delivery (OHD)

Introduction

After a slow start, particularly in France, B2C (business-to-consumer) services are now booming, which sometimes leads to fractures, especially in logistics (order-picking and deliveries). It therefore seems urgent to worry about deliveries to Internet users, either directly at home or at pick-up points, because city logistics could become a key factor in the success or failure of online selling. In past decades, city logistics dealt with the main problems of urban freight distribution, studying freight movements in urban areas and proposing solutions to reduce congestion and pollution. Moreover, end-consumer movements, related to household supply, have recently been studied from a city logistics point of view (Gonzalez-Feliu et al., 2012). However, most of these studies take into account only traditional shopping trips, avoiding several categories of trips related to e-commerce and teleshopping distribution channels. Moreover, e-commerce-related studies focus on customer choices or optimization approaches in fields such as culture and clothing (Rohm & Swaminathan, 2004; Taniguchi & Kakimoto, 2003), whereas e-grocery, one of the fields with a stronger potential, is less studied (Durand & Vlad, 2011).

For this reason we decided to focus on e-grocery. We wish, in particular, to focus on interactions between e-grocery end-consumer flows and city logistics systems. Thus, one of our first objectives will be to consider logistics solutions adopted by online retailers. We present the two basic models of e-grocery distribution: order-picking at a site dedicated to this and in-store picking. Second, we evaluate the three distribution systems adopted by French e-grocery retailers. We focus in particular on the impact of these systems on consumers' purchasing journeys and, to this end, we propose a simulation approach empirically built from data surveyed to make a comparison of the systems studied.

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E-Supply Chain Management

Logistics plays a major role in e-commerce success, yet its status remains secondary. Indeed, when online shoppers receive their order under expected conditions, there is no reason to linger there. However, when logistics leaves something to be desired (delay, theft, loss, etc.), it can make consumers less interested in continuing to purchase using the website. Logistics performance is therefore an obviously integral part of the online transaction.

At the same time, as underlined by Baglin et al. (2005), B2C imposes specific logistics that, in particular, depend on the products sold. There are almost as many kinds of e-logistics systems as families of products; cyber-storekeepers are guided, of course, by the nature of their products in choosing them. It also depends on the nature of the retailer: a storekeeper whose only presence is online will not choose the same options as a colleague who also sells in-store. Essays concerning typologies are regularly the object of academic research in this area, in particular concerning model choice criteria (Durand, 2008).

According to Dornier and Fender (2001), logistics is an essential component of web-based retailers' strategies, also called e-tailers. More precisely, two main components can be identified in strategic logistics management for e-commerce activities: inventory strategies and transport schemes. If we observe online order-picking (related to inventory), we can define two basic organizational models (Paché, 2008): (1) order-picking at a dedicated site, for example, an upstream national or regional warehouse (warehouse-picking) or closer to the place of consumption in a downstream local depot (depot-picking); and (2) store-picking.

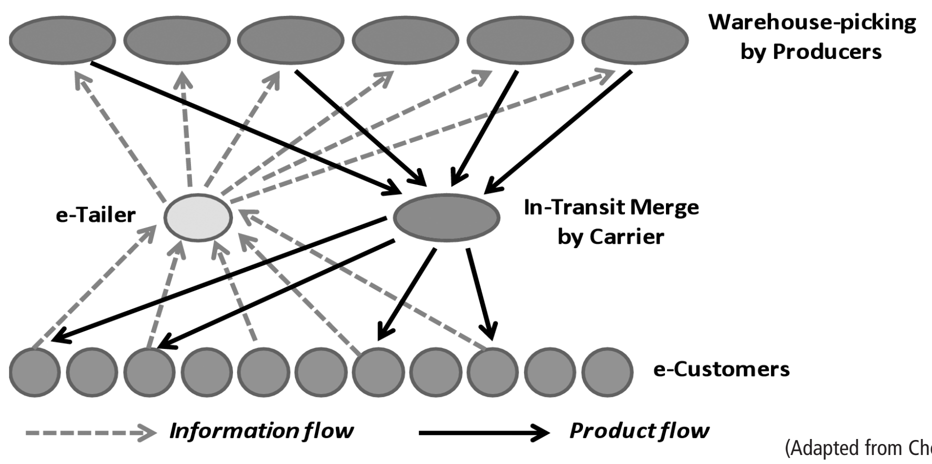
Order-picking at a dedicated site

According to De Koster (2002), when the number of SKU (stock keeping units) for B2C is large (several tens of thousands) and when the online activity is not marginal (several hundreds of orders a day), storage at a specific site, dedicated to e-commerce, seems a necessity. Three different inventory schemas are considered: (1) upstream storage, in producers' warehouses for slow-moving items; (2) more downstream storage, for fast-moving products in national (or interregional) warehouses dedicated to e-commerce and managed by distributors and/or LSPs (logistics service providers); and (3) far downstream storage, for very fast-moving articles in urban (or suburban) depots, directly connected to online sales structures and directly managed by distribution companies.

Let us specify that the first alternative, that of the order-picking at producers' warehouses, contains several variants (Durand, 2010). We will look at the variant that minimizes the number of HDs (home deliveries) and examine its process (see Figure 1). First, online consumers place orders of several lines (that is to say of several SKUs) on a retail website. Then, the cyber-storekeeper relays the orders to the specific producers. These producers carry out order-picking, giving their parcels to a solitary LSP to avoiding multiple deliveries (Monnet, 2008). For that, the LSP groups parcels by customer (it's a type of cross-docking operation) and the suppliers' orders are thus strengthened. Once assembled, the LSP starts to deliver orders to the Internet users. A single HD per household makes this alternative unmistakably the most economic and the most ecological variant.

Let us add that we regularly encounter this first alternative in the editorial e-supply chain because of the several million articles available online. However, it is absent in the e-grocery sector. Indeed, the offer of cyber-markets is only composed of approximately five or six thousand very fast-moving articles. Consequently, grocery items are more often stored downstream in warehouses (or depots) allocated to distributors. It corresponds to the two other order-picking

Figure 1
Upstream warehouse-picking and in-transit merge operations (Adapted from Chopra & Meindl, 2004)



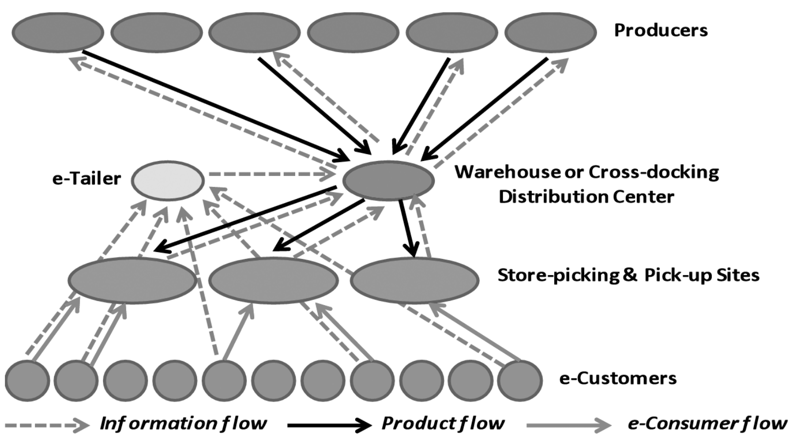
(Adapted from Chopra & Meindl, 2004)

alternatives. According to Yrjölä (2003), a logistics unit dedicated to e-grocery operations justifies itself because the number of online consumers per km^2 is increased. In terms of final delivery, we also observe several variants: the management of HD being integrated in or delegated to LSPs, or a hybrid of the two.

Store-picking

Online retailers who choose to lean on a network of existing stores opt for a very simple process and one that is quickly operational. This model, which was the cornerstone of Tesco's e-grocery success, is based on online orders being transferred to the store nearest to the e-consumer's location. Order-picking is often made by employees of the store concerned (they pick articles from shelves) and, once the basket has been filled, HDs are, in general, made by the storekeeper or by an LSP, with a multi-temperature vehicle. So, using existing infrastructures, store-picking is characterized by a reduced investment and, therefore, by a very short ROI (return on investment). Another asset of this model is the fact that online consumers can opt to pick up goods purchased directly in-store (as shown in Figure 2), reducing logistics costs in this way. So, this model also constitutes an OHD (out-of-home delivery) alternative. However, this second model contains a risk: that of the disturbance of traditional in-store customers by pickers. Faced with this eventuality, which could result in leaks of consumers, Ogawara et al. (2003) suggest adopting warehouse-picking as soon as the customer catchment area has good potential. In any case, the store-picking model constitutes the proof that online business does not mean the death of outlets: indeed, their mobilization could be an invaluable support to e-logistics.

Figure 2
Downstream store-picking and e-consumers pick-up operations (Adapted from Chopra & Meindl, 2004)



Frame 1
Methodology of research used

The mobilized approach is of a qualitative nature. Fifteen semi-directive interviews, of an average duration of one hour and thirty minutes, were conducted: three in the floral sector (Interflora, Aquarelle, and Bebloom), two in the editorial sector (Fnac and Alapage), and ten in the food sector with seven French large distributors (Carrefour, Auchan, Cora, Galeries Lafayette, Intermarché, Système U, and Leclerc). These conversations were then the object of an accurate analysis of the speech, in the same way as Paillé and Mucchielli (2003), and therefore revealed the perspectives of 12 e-supply chains.

These two basic models of B2C logistics continue to be the object of academic works (Marouseau, 2007). But, we already can find them in the practices of online storekeepers, in particular in the French market.

Logistics practices observed by French cyber-traders

To sketch a state-of-the-art logistics system practiced by French cyber-storekeepers, we adopted a research methodology (see the box) that we apply to three business sectors: floral, editorial, and food.

The research shown in Table 1 gives a summary, allowing us to note that the studied e-supply chains often lean on organizations stemming from the old economy and therefore already integrate preoccupations about urban logistics.

Of the three business sectors, we had time only to look at e-grocery in depth; we conducted numerous interviews in this particular sector. It is for that reason that we are going to limit our article to discussing e-grocery, focusing specifically on the evaluation of three distribution systems that the French distributors Intermarché and Auchan have developed. In the future, we will conduct additional interviews in the floral and editorial sectors and analyze them.

The* Expressmarché *logistics model Having consumers pick up their goods directly in the store, an alternative to store-picking, seems to have convinced the most hesitant French distribution brands (Durand, 2009). The grocery retailer *Intermarché* chose this model to control its logistic costs. Three hundred of their supermarkets, called *Expressmarché,* are now cyber-markets. Intermarché chose to take advantage of the density of its network (a selling point every 18

Table 1
Logistics practices observed by French cyber-storekeepers (Durand, 2007)

Type of e-supply chain	Supply	Flow management	Logistics model	LSPs involvement
Floral products	**Limited** Only some SKU tens	**Pull** Bunch built-to-order	**Store-picking** for *Interflora* (brick-and-mortar)	**None** (insourcing of deliveries)
			Warehouse-picking for *Aquarelle* & *Bebloom* (pure players)	**Transport outsourcing** (*Chronopost*…)
Editorial products	**Very large** Several millions SKUs	**Push** Large **stocks**, **upstream** by suppliers	**Warehouse-picking** - **insourced** by *Fnac* (brick-and-mortar) - **outsourced** by *Alapage* (pure player)	**Transport outsourcing** (*Chronopost*…) and **Storage outsourcing** by *Alapage*
Food products (e-grocery)	**Large** Several thousand SKU	**Push** Large **stocks**, **downstream** by retailers (brick-and-mortar)	**Store-picking** for *Intermarché*, *Système U,* and *Leclerc*	**None** *Système U* and *Leclerc* don't practice HD
			Warehouse-picking for *Carrefour, Auchan, Cora, and Télémarket*	**Adaptable** *Carrefour* practices outsourcing, whereas *Auchan* insources

km). Not only can HD be accomplished because of this very good territorial cover, but Expressmarché also made available two pick-up or OHD alternatives: the classic in-store pick-up and the drive-through, which means that Internet users do not need to leave their vehicles.

The* Auchandirect *logistics model

Auchan is one of the first large French retailers to have invested in the e-grocery market by launching *Auchandirect* in 2001. At this time, the customer catchment area, served by the central warehouse of Chilly-Mazarin (near Paris), was limited to the southern region of Paris. Since then, while remaining committed to warehouse-picking, *Auchandirect* has widened its national coverage by opening five new sites: a second in Ile-de-France and four near major cities (Lyon, Lille, Toulouse, and Marseille). In 2004, Auchan expanded its digital distribution, developing an alternative parallel cyber-market called Chronodrive.

The* Chronodrive logistics *model

The *Chronodrive* alternative corresponds to an original OHD concept. Orders are prepared in nearby depots that are located in big city suburbs. To differentiate from warehouse-picking, we use the term depot-picking to describe the activity of these infrastructures, which are exclusively dedicated to storage and to order-picking (they are not stores). Internet users come to pick up and adjust their orders. If warehouse-picking can be associated only with HD and if the store-picking authorizes both HD and basket pick-up, *Chronodrive* allows only the order pick up. Except for the fact that it favors the territorial extension of the of *Auchan's* e-grocery activities, the *Chronodrive* alternative allows the distributor to bypass the HD problem. Currently about 20 sites are operational in France and profitability seems satisfactory. New depots are expected to open, the objective being, according to Silly (2008), to quickly reach one hundred sites.

We have just sketched a partial state of the logistical alternatives used by French cyber-storekeepers, more exactly, by French e-grocers in addition to their brick-and-mortar systems, where it is possible to receive backing from an existing network of stores. It is indeed necessary to know that there had been some French pure cyber-storekeepers, who dashed into e-grocery and failed to deliver goods to their customers because, effectively, they didn't have networks of stores. In summary, we have to underline that, faced with difficulties caused by HD, French e-grocers are more and more interested in two types of OHD: (1) pick-up directly from their stores; (2) pick-up from suburban depots, such as used by *Auchan* via its *Chronodrive* model.

Let us underline that, generally speaking, OHDs are less expensive than HDs, at least for e-grocers. Nothing proves, however, the ecological interest of OHD. Browne et al. (2005) show that OHDs can result in an increase of greenhouse gas (GHG) emissions. This system can generate more movements than traditional in-store shopping. Such uncertainties about the advantages of OHD over HD require simulations of typical scenarios of urban logistics and, especially, comparative analysis of the environmental disturbances produced by each of these scenarios to be carried out. The next section will look at this by studying three e-grocery logistics models.

Interactions Between E-Grocery and City Logistics

As stated by Ségalou et al. (2004), the urban goods movement (UGM) is composed of several categories and subcategories. In this article, we are interested in two types of movements: last mile inter-establishment movements and end-consumer movements, which are required to evolve with the development of e-grocery. Inter-establishment movements represent about 40% to 45% of the total UGM in an urban area (Patier, 2002). The last-mile flows of retailing activities are estimated to be 11% of total UGM (Routhier et al., 2009), whereas those related to only grocery are about 9%.

End-consumer movements represent about 45% to 50% of the total UGM (Patier, 2002). Nowadays, most of these flows are tradition shopping trips, but the new forms of distribution need to be taken into account from a global city logistics point of view. E-grocery currently represents less than 5% of total shopping trips but could represent, according to Georget et al. (2008), more than 15% by 2020. Regarding transport models from a city logistics point of view, three main strategies are commonly seen in practice: (1) HDs from a specific warehouse, (2) HDs from a store, (3) OHDs through a store or a depot.

Home deliveries from a dedicated warehouse

To receive HDs from a specific warehouse, orders are prepared by a warehouse-picking process. Important changes are then noted in the supply chain because this new and dedicated warehouse is not located in a peripheral area. The ordered products are delivered to the place of consumption using light goods vehicles, through an optimized route. These trips are made by delivery vehicles and can be assimilated to traditional e-commerce HDs with more restrictive constraints (Durand & Vlad, 2011).

Home deliveries from a traditional store

To receive HDs from a supermarket, orders are prepared by a picker in the lanes and in the shelves of a store. This outlet, generally a supermarket of 2,000 square meters, is located on the outskirts of the urban area, a few miles away from the consumer home. There are no major changes in the supply process of the store. The purchased products are either directly delivered to the home or picked up by the consumer, mainly by car, avoiding queues and waiting times. These trips can be then assimilated to personal trips for shopping purposes (Gonzalez-Feliu et al., 2012).

Out-of-home deliveries via a store or a depot

The main difference in the supply process to make OHDs through proximity pick-up points is new local depots. This time, indeed, the ordered products are directly prepared either in a depot (that is, in a new site) through a depot-picking process or in a store by a classical store-picking process. These two different types of points, in which the products are finally picked up by the final consumer, are both located near the place of consumption (Augereau & Dablanc, 2008).

Finally, we would like to offer a short overview of e-grocery development. If online sales affect almost all business sectors, one has to admit that e-grocery is still a niche market: its turnover was only about 1.2 billion euros in 2009 in France. Additionally, currently only about three million French Internet users use online supermarkets. This type of sale is attractive first for reasons of practicality and of time savings. Consumers want to save time during food purchasing in two ways: (1) reducing (or even by eliminating) their round trip travel time to the store and also the time of spent looking for a parking space and (2) eliminating waiting times at food preparation counters and at checkout. Internet users underline the practicality of online sales, also in two ways: (1) online stores are continuously open, 24 hours a day - therefore this scenario allows transactions at any time of the day - and (2) online orders can be directly delivered or dropped off at pick-up points. Consideration of environmental problems also seems to push households to increase their Internet purchases: they see a positive environmental impact because of the perceived reduction of movements and of GHG.

The cost of this service, however, seems to constitute the major obstacle to e-grocery development because, in the mind of many French people, online shopping is more expensive: either the price of products sold on Internet is higher because it integrates the cost of basket picking and delivery costs or the price of articles is the same as in the store but online shopping is added to the logistic service costs. Less sensitive to this cost than the other SPCs (socio-professional categories), the SPC+ (upper SCP) is also, at the moment, the category most attracted by e-grocery: more than half of their food income is already being made in cyber-markets, where the offer is particularly reduced with only 7,000 SKUs compared to 40,000 in a traditional supermarket.

Simulation as an Evaluation Tool For E-Logistics

In this section, we provide an assessment of three distribution scenarios adopted by French e-grocers: (1) one that allows only warehouse-picking, which is translated into HD services only; (2) one based on store-picking and that combines HD services with in-store, pick-up shopping trips; and (3) one that conversely offers only a pick-up service from a nearby depot.

The proposed scenarios

In order to isolate the effects of e-commerce from other effects, such as population growth or changes in retailing demography, we propose several hypotheses based on changing only the end-consumer supply organizational schemas (with the respective inter-establishment changes if applicable):

- S0: A reference situation corresponding to those of the urban area of Lyon in 2005-2006 (Gonzalez-Feliu et al., 2011).

- S1: A "**warehouse-picking and HD**" scenario. This hypothesis supposes that the only distribution channel for e-grocery services is that of HDs using a warehouse-picking strategy. This supposes the use of a regional depot and then simulates HD routes from this depot. This scenario supposes that only large e-grocery groups are proposing these services.

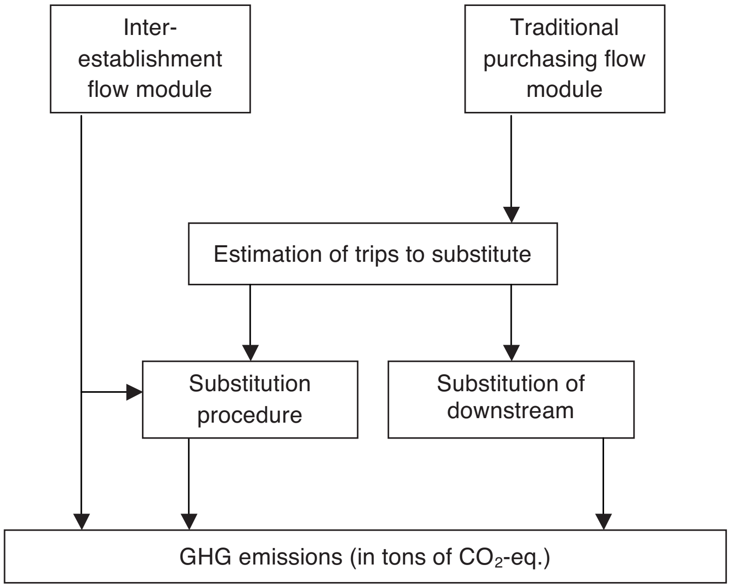
- S2: A "**store-picking and HD**" scenario based on the assumption that all households asking for e-commerce services are served by a store within their urban area. This scenario supposes two types of retailing activities: small retailers who will cover small routes from all locations within the urban area and big stores that will use peripheral stores as the starting point of longer routes.

- S3: A "**depot-picking and OHD**" scenario based on the assumption that only depot-picking can be used by inhabitants for e-commerce purposes. These depots are located in areas that already have a supermarket in order to obtain a realistic set of depots.

For each hypothesis, a quota of 10% to 50% of e-commerce users is supposed. Moreover, both warehouse-picking and store-picking strategies will be simulated each time.

Simulation procedure

Figure 3
Integrated simulation procedure chart



(Adapted from Gonzalez-Feliu et al., 2012)

The simulation procedure chart is shown in Figure 3. We assume that all strategies follow a store-picking inventory schema because this is nowadays the most interesting in terms of environmental and social impact (Durand, 2010). For this reason, only B2C flows will be simulated.

The simulation procedure is an adaptation of Gonzalez-Feliu et al.'s method (2012), defined as follows. First, following each scenario's assumptions and hypotheses, the input data files are generated. Note that the simulation needs, as input, an e-commerce user rate defined as the percentage of the total number of households using e-commerce. From these different rates, we estimate the number of shopping trips to be substituted, using the substitution procedures defined by Gonzalez-Feliu et al. (2012). Then, we use a catchment area model (Gonzalez-Feliu et al., 2011) to identify each pair of origin-destination, that is, to find, for a potential delivery, its origin (a store, a warehouse, or a depot) and its destination (a household). Following Alligier's (2007) and Durand & Vlad's (2011) considerations, we define two types of HD routes, one for store-picking deliveries and one for warehouse-picking last-mile trips. Then, we estimate the routes using a procedure adapted from Gendron and Semet (2009) and Routhier et al. (2009). This procedure works as follows: given a starting point and a set of possible destinations of a route, we assign a number of destinations to the route in order to minimize the total transport cost, respecting two main constraints: (1) the total number of driving hours including the driver's breaks is less than nine (legal value) and (2) the vehicle capacity is not reached. The time constraints related to the customer's preferences are taken into account following an empirical method (Gonzalez-Feliu, 2008).

The B2B flows delivering the different retailing activities of a city are extracted from a general diagnosis using the Freturb model (Routhier & Toilier, 2007). In order to evaluate the real impact of B2C flows on urban freight transport, we take into account all the urban B2B flows, where last-mile retailing activities represent less than 10% in terms of total road occupancy rates. These flows are given by Freturb's generation module using an establishment file and a geographic division of the simulation area as inputs. Then we substitute the flows corresponding to the new B2C activities (i.e., warehouse-picking HDs and depot-picking HDs, whose impact on B2B flows is positive [decrease of the number of last-mile deliveries]).

Finally, the results are aggregated to estimate the total travelled distances by type of vehicle. Three indicators are proposed: (1) the overall distance, in kilometers, for each category of flows; (2) the road occupancy rates, in PCU[1]; and (3) GHG emissions rates, in tons of equivalent CO2, estimated using the IMPACT ADEME software (ADEME, 2003). The area of application is the urban community of Lyon, the second largest urban area in France in terms of population, Paris metropolitan region being the first. This choice was made mainly because of data availability (all the required data files are complete and have been previously processed for modeling and simulation tests). The Lyon urban area consists of about 2,000,000 inhabitants and 800,000 households. We used a database that derives from the 2006 household trip survey of the Lyon urban area (Grand Lyon, 2011) and the 2005 establishment of a censorial database (SIRENE[2]).

Table 2
Simulation results in total travelled distances in the Lyon urban area (km/year)

		IEM	PDM	ST	Total
Reference		625	0	1350	1975
1	10%	-0.24%	6.13%	-0.10%	4.05%
	20%	-0.57%	12.20%	-1.00%	7.48%
	30%	-1.23%	18.33%	-2.10%	10.71%
	40%	-1.80%	24.47%	-3.20%	13.97%
	50%	-2.36%	30.53%	-4.30%	17.18%
2	10%	0.00%	1.33%	-0.40%	0.64%
	20%	0.00%	2.73%	-1.30%	0.98%
	30%	0.00%	4.07%	-2.20%	1.28%
	40%	0.00%	5.47%	-3.20%	1.55%
	50%	0.00%	6.80%	-4.10%	1.85%
3	10%	-0.19%	0.40%	-1.30%	-0.68%
	20%	-0.43%	0.75%	-3.20%	-1.81%
	30%	-0.61%	1.15%	-5,00%	-2.83%
	40%	-0.80%	1.55%	-6.90%	-3.91%
	50%	-1.04%	1.95%	-8.80%	-5.01%

(IEM: inter-establishment movements, PD: proximity delivery movements, ST: shopping trips)

Simulation results

We are thus able to establish a number of results from which we could develop a comparative analysis of the three systems studied. These results are expressed in kilometers (see Table 2), which are directly linked to the transportation costs identified by the e-grocery and by calculating the road occupancy rates (in km-PCU) and then the GHG emissions (in tons of CO2 equivalent units). Note that the reference scenario produces nearly 2,300 billion kilometers per year in Lyon's urban area. Moreover, the downstream delivery flows in 2006 were considered negligible.

From them, we can observe that scenarios 1 and 2 lead to an overall distance increase. In all cases, pick-up and delivery flows, whose costs are assumed by retailers proposing proximity delivery services, are not negligible. Thus, we can state that these costs have to be taken into account not only in the optimization process but also in pricing and tariff developments because they have an effect on the company benefit margins. More precisely, the use of peripheral warehouses for only HD for e-grocery leads to large HD distances (each route is about 150 to 250 km, according to Durand and Vlad [2011], and delivers 35 to 50 households). This scenario (1) is the less favorable in terms of travelled distances. Scenario 2, which mixes HD and pick-up services, follows the same trend, but with much lower impacts. In both cases, the travelled distances of HD are bigger than the gains observed on both last-mile B2B flows and shopping trips. This can be explained by the fact that people individually optimize their shopping trips, sometimes by making work-shopping-household trips, which lead to a distance increase of only 2 to 5 km per trip (Gonzalez-Feliu et al., 2011), much lower than the associated distances of a delivery route. Scenario 3, which uses nearby depots, presents a decreasing trend of distances. This is due to the fact that depot delivery routes are better optimized than HD routes. This scenario is then the most favorable but the gains are contained: about 5% of overall distance reduction, mainly due to supermarket and hypermarket shopping trips decreasing.

Regarding road occupancy rates, we can observe that scenario 1, which uses specific peripheral warehouses with only HD for e-grocery, and scenario 2, which mixes HD and pick-up services, are less favorable in terms of road occupancy rates than scenario 3, which uses nearby depots. In the two first scenarios, the decrease in individual movements related to purchasing do not efficiently compensate the increase due to the use of commercial vehicles for HD services, which does not seem to be optimized. In scenario 1, almost all the gains made in terms of shopping trips are neutralized by long and sub-optimized HD routes. In scenario 2, these routes are

1. Road occupancy rates are estimated in private car units (PCU), defined as follows: 1 private car = 1 PCU, 1 light goods vehicle = 1.5 PCU, 1 simple truck = 2 PCU, and 1 semi-articulated = 2.5 PCU.
2. The SIRENE files are produced by the French Institute of Statistics (INSEE).

Table 3
Simulation results in road occupancy rates (km-PCU/year) and in tons of CO2-eq./year in the Lyon urban area

		Road occupancy rates				Tons
		IEM	PDM	ST	Total	CO2-eq
Reference		1320	0	1350	2670	320 000
1	10%	-0.50%	9.20%	-8.90%	-0.10%	-0.10%
	20%	-1.20%	18.30%	-19.00%	-1.00%	-1.20%
	30%	-2.60%	27.51%	-29.10%	-2.10%	-2.40%
	40%	-3.80%	36.69%	-39.30%	-3.20%	-3.30%
	50%	-5.00%	45.80%	-49.40%	-4.30%	-4.60%
2	10%	0.00%	2.00%	-2.80%	-0.40%	-0.40%
	20%	0.00%	4.11%	-6.90%	-1.30%	-1.30%
	30%	0.00%	6.10%	-10.90%	-2.20%	-2.20%
	40%	0.00%	8.19%	-15.00%	-3.20%	-3.20%
	50%	0.00%	10.20%	-19.00%	-4.10%	-4.10%
3	10%	-0.39%	0.80%	-3.10%	-1.30%	-1.40%
	20%	-0.90%	1.50%	-7.40%	-3.20%	-3.20%
	30%	-1.31%	2.30%	-11.70%	-5.00%	-5.10%
	40%	-1.70%	3.10%	-16.00%	-6.90%	-7.00%
	50%	-2.18%	3.90%	-20.30%	-8.80%	-9.00%

(IEM: inter-establishment movements, PD: proximity delivery movements, ST: shopping trips)

better optimized (the starting point is in general inside the urban zone or in the first periphery) but, in general, car pick-up generates more distance and, thus, more road occupancy rates than traditional shopping. Scenario 3, the “pick-up everything” is more favorable, but the gains in road occupancy rates remain small: less than 9% gain in tons of CO2-eq. when the use rate is 50%.

If we convert these results into GHG emissions rates, we observe than the variations are similar (the differences between road occupancy rates and GHG emissions present differences of about 0.2% to 0.4%). Note that GHG emissions rates have been estimated assuming the current fleet distribution, that is, almost all vehicles are diesel, and the ages of these vehicles are distributed using ADEME's (2006) ratios. For these reasons, road occupancy and GHG emissions rates almost match. Making further assumptions, for example, transferring freight from high-polluting schemes (because vehicles used are more polluting) to B2C schemes, using methane or electric vehicles, will increase these gains (in terms of GHG emissions) without altering the others (travelled distances and road occupancy rates). This highlights an interesting question: what kind of action has to be considered to create CO2 reduction? Technology does not seem to change the organization of a supply chain, and only organizational changes seem to be fundamental for an efficient GHG reduction (Routhier et al., 2009). Indeed, only organizational changes (as shown in our scenario simulation) have an impact on congestion. However, it is important to support the choices of public authorities and private actors (Gonzalez-Feliu & Morana, 2010) to help them to find a convergence between individual cost-reduction targets and a collective vision of congestion reduction and environmental-friendly practices.

Conclusion

In this article, we have given an overview on the latest developments in e-grocery distribution and presented a scenario analysis using an empirical simulation approach. Three scenarios, each of them related to a new form of B2C services (HDs, shopping trips in a car, and proximity pick-up points) have been presented and simulated. We can observe that scenario 1, “all-HD,” and scenario 2, which mixes HD and pick-up services, appear to be less favorable than scenario 3. Although the individual purchase movements decrease, the use of commercial vehicles for all-HD does not seem to be optimized in this configuration. The resulting gain in GHG emissions is respectively about 4.3% and 4.1% when the use rate is 50%. Scenario 3, the “pick-up everything” would apparently be most favorable: almost a 9% GHG emission reduction when the use rate is 50%. This reflects a sharp decline in motorized shopping trips, the assumption being made that the depots are located near the heart of residential neighborhoods and the density of these points is sufficient to lead to changes in user behavior, including the use of their car. Finally, through the external impacts of household supplies, we show that consolidation of HDs and proximity reception points (where most trips are made on foot) can lead to significant savings.

The remaining question concerns the managerial implications of the three scenarios. The first scenario, in which 40% of e-shoppers opt for an in-store pick-up service, raises the key question of the nature of the operator who must support the HD services. Does the e-tailer assume this role? Shouldn't an LSP assume that role? This second alternative would be to fine-tune the prospect of consolidating and sharing online order processing on urban platforms to reduce the number of HDs per household.

Regarding scenario 2, the “all-HD” choice, the internalization of HD appears relevant because it generates transport cost savings. However, LSPs specialized in the field in France, starting with Star's Service, for example, also seem able to offer quality services at a very reasonable price. Finally, the local depot option is the most interesting in terms of reducing CO2 emissions but also the most costly and takes the longest to implement. The deployment of local depots requires significant investment (Augereau & Dablanc, 2008), which inevitably leads to higher management costs. A pooling of these infrastructures through urban platforms could then be the best solution to the urban delivery problem (Paché, 2010), although this strategy remains long and arduous (Gonzalez-Feliu & Morana, 2010).

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