Challenges in last-mile e-grocery urban distribution: have new B2C trends a positive impact on the environment?

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Abstract

The business to consumer distribution services (B2C), mainly related to e-commerce, know nowadays a real boom that is sometimes accompanied by fractures. To better understand this fast-changing situation and support researchers and practitioners, this chapter proposes a scenario assessment analysis focused on the new B2C strategy trends and the joint co-ordination of e-commerce stakeholders to better optimize consumer's delivery flows. First, the two main logistics solutions adopted by online retailers are introduced. Second, the main customer's delivery services in France are presented. The proposed scenarios take into account the relations between urban development and B2C logistics schemes. Finally, the scenario assessment method is introduced then environmental impacts are estimated and analyzed each scenario.

Keywords: e-commerce, B2C logistics, end-consumer delivery strategies, environmental impact.

1. Introduction

After a slow start, particularly in France, e-commerce services know nowadays a real boom that is sometimes accompanied by fractures, especially those related to the distribution of the purchased products. For this reason it seems to be urgent to worry about business to consumer (B2C) transport flows. These flows are in general deliveries from a commercial activity, a warehouse or a depot to a location near the consumption place, either at home or on proximity reception points. In this context, city logistics can be a key factor in online selling development success or failure. In the last decades, city logistics has been developed to deal with the main problems of urban freight distribution, studying freight movements in urban areas and proposing solutions to reduce congestion and pollution.

This chapter aims to study the impacts of both retail urbanistics policy and e-grocery development on household shopping trip behavior, examining the relations between e-grocery end-consumer flows and city logistics systems. First, the two main logistics solutions adopted by online retailers are described, focusing on both inventorying strategies (order picking) and end-consumer supply schemes (freight transport and shopping trips). Then, four current French logistics models are introduced. Finally, the asses-sent and further analysis of 6 scenarios is proposed. The four first scenarios derive from the generalization of each proposed logistics model. The other two scenarios mix these four models, one following current trends and the other taking into account the relations between urban development (and so household locations) and e-grocery B2C services. The scenarios are then simulated and compared to a real reference situation (the urban area of Lyon in 2006). As a conclusion, the main practical implications of these scenarios are proposed.

2. The logistics of e-commerce

Logistics plays a major role in e-commerce success, yet its status remains secondary (Durand and Gonzalez-Feliu, 2011). Indeed, when an online store receives and sends its order under the expected conditions, the customer has no reason to complain, but when the deliveries present some nuisances (delays, thefts or losses, among others); it has direct consequences on the continuation of purchases on the frequented website (Durand, 2010). Moreover, B2C services need specific logistics that, in particular, depend on the products sold (Baglin et al., 2005). According to

Durand et al. (2010), there are almost as many e-logistics as families of pro-ducts. Moreover, the choice of each store's logistics schemes is guided by both the nature of products and the type of retailer. Indeed, a storekeeper, only present on-line will not choose the same options as a colleague who also sells in-store. Concerning these logistics schemes, they are composed of two main components: inventory strategies and transport schemes (Durand and Gonzalez-Feliu, 2011).

2.1. Inventory strategies in e-commerce distribution

According to Dornier & Fender (2001), logistics is an essential component of web-based[1] retailers' strategies. Inventory strategies for e-retailers are directly related to online order-picking (Paché, 2008). Two basic organizational models can be defined: order-picking at a dedicated site and store-picking. According to De Koster (2002), when the number of stock keeping units for B2C is large (several tens of thousands) and the e-commerce part of the business is not marginal (several hundreds of orders a day), storage on a specific site, dedicated to e-commerce, seems a necessity. Three alternative inventory schemes have been considered:

- *Upstream storage*, in producers' warehouses for slow moving items. In this organizational model, the facilities and the inventory management are in general followed by the producer itself and the distributor takes the role of a customer in the inventory management chain,
- *Storage at distributor's platforms*, for fast moving products, in national or regional facilities belonging to the distribution operator or its subcontractors and exclusively dedicated to e-commerce. These inventory schemes can be managed by the distributor itself of a specific logistics providers,
- *Downstream storage*, for very fast moving articles in urban (or suburban) depots, directly connected to on-line sales structures and managed by distribution companies.

Order-picking in producers' warehouses, contains several variants (Durand, 2010). In this chapter the variant that minimizes the number of home deliveries (cf. Figure 1) is presented to examine its process. First, on-line consumers purchase products on a retail website, making a group of orders. Then, the website follows the information about these orders to the concerned producers. The latter carry out order-picking for its corresponding products, sharing the transportation operations on the same logistics

[1] Also called e-tailers (Durand and Gonzalez-Feliu, 2011)

provider to avoid multiple deliveries. Once assembled, orders soon start to be delivered to Internet users. The fact that each household receives one delivery vehicle makes this option the most economic and environmental-friendly variant.

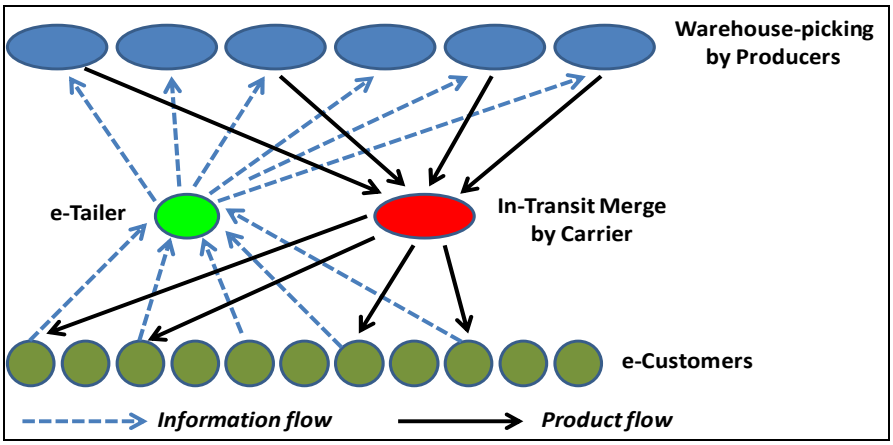

Fig. 1. Upstream warehouse-picking and in-transit merge operations (adapted from Chopra and Mendl, 2004)

This alternative is extremely developed in the editorial supply chain, because of a plethoric offer of several million on-line articles, but it is almost absent in the e-grocery sector (Durand, 2009). Indeed, the offer of cybermarkets is only composed of approximately five or six thousand very fast moving articles. Consequently, grocery items are rather stored downstream in warehouses (or depots), allocated to distributors. It corresponds to the two other order-picking alternatives. According to Yrjölä (2003), a logistics unit dedicated to e-grocery operations justifies itself since the number of on-line consumers per km^2 is increased. Regional warehouses are in general used by big e-grocery groups, like Carrefour and Auchan (TL&Associés and LET, 2009), whose volumes and strategic axes justify the investments that suppose to implement a network of national and/or regional e-commerce logistics platforms. On the other hand, smaller groups can also choose order-picking on a dedicated site, but are in general urban or peri-urban platforms a big store or a local platform, not only dedicated to e-commerce but also to traditional distribution. Finally, urban depots are also used in France by big groups in some big cities (Paris, Nantes) for proximity deliveries (Durand and Vlad, 2011).

Concerning last mile deliveries, several variants can also be observed: the management of home deliveries being integrated in or given to a subcontractor, although mixed logistics systems are also found in practice.

On-line retailers, who choose to lean on a network of existing stores, prefer a simpler and quicker operational process. This model is based on the fact that on-line orders are transferred to the store nearest to the e-consumer's location. Order-picking is often made by employees of the concerned store and, once commands are prepared, home deliveries are made by the storekeeper or by a logistics provider. In this way, store-picking strategies suppose reduced investments and, therefore, a very short return on investment. Another asset of this model is in the fact that on-line consumers can opt to pick-up goods purchased, directly in store (as shown in Figure 2), avoiding transportation costs in this way. However, this second model contains a risk: that of the disturbance of traditional in-store customers by pickers. Faced with this eventuality which could entail 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 on-line business does not mean the death of outlets: indeed, their mobilization could be an invaluable support to e-logistics.

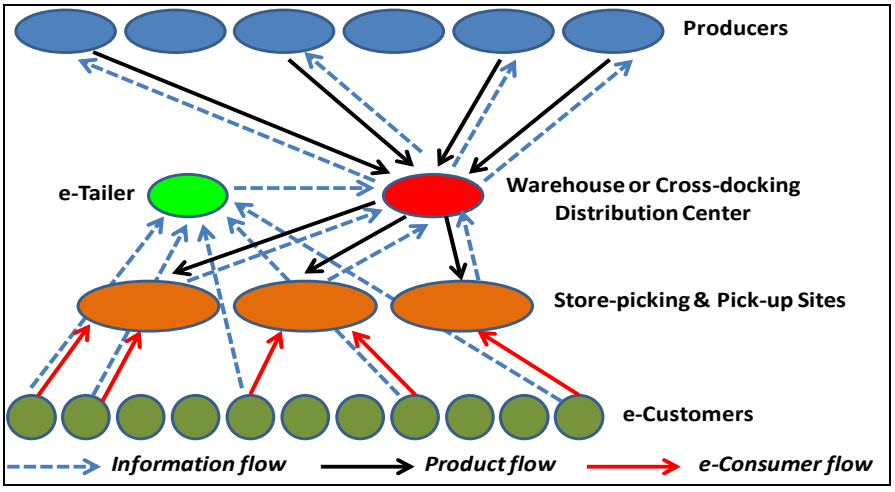

Fig. 2. Downstream store-picking and e-consumers pick-up operations (adapted from Chopra and Mendl, 2004).

The existence of an urban specific segment of a transport chain for the first and last kilometer is one of the main particularities of the mobility of goods in major cities. This urban segment has an own characteristics as the passage through a terminal means in most cases a transformation of the forms of mobility: the first and last kilometer, those of the final distribution or initial, carried out with different vehicles (generally smaller, often older and pollutants), and often with different operators (with a predominance of small subcontractors) and the rest of the transport chain.

One of the main characteristics of freight transport in major cities compared to smaller cities is the very common passage of goods through a terminal during their transport. Thus, before being delivered in an urban area (or sent from this urban area), a product has every chance of passing through a logistics terminal (a cross-docking terminal), in other words, a nodal point at which the goods will be at least transferred from one vehicle to another, and often will undergo some operations (storage, packaging).

It is the same for the delivery of goods ordered online. These goods are prepared at a logistics terminal before their final delivery to the customers (households). Changes in the location of these terminals will directly affect the distances and routes used by vehicles to deliver urban areas.

Increasingly common in large urban areas, the logistics facilities should find welcoming places. Two logic reasoning patterns are at work in the spatial arrangement of logistical equipment. There is a significant part in developing large multi-specialty areas and logistics facilities in a coherent architectural and managerial set. "Powerful logistics nodes" (Savy and Liu, 2009) where are installed one or several logistics areas, appropriate the economic landscape of the Paris region. In addition, many logistics terminals disperse over a large part of metropolitan France. Last thirty years, logistics terminals have been developed in areas located over 30 km of urban centers (Mykolenko, 2003). Dablanc and Rakotonarivo (2010) have demonstrated this logistics sprawl by using the case of parcel service terminals in the Paris region.

If logistics terminals have moved away from dense cities, the population remains concentrated in the city center. Logistics sprawl of terminals has an influence on the increasing distances to travel to deserve the urban population that is to say about the environmental impacts of urban delivery, like the delivery of e-commerce.

Deliveries of e-commerce are mainly characterized by deliveries to individuals. The major difficulty of these deliveries is the absence of the consignee. This requires transport operators to pass a second or a third time and creates a disorder in their organization and a waste of time. A waste of time involves additional costs. The delivery of last mile is therefore one of the obstacles to the development of the delivery of e-

commerce. This is why the establishment of pick-up points is one possible solution to these high costs of urban distribution (Augereau et al., 2009).

2.2. Transport strategies and final distribution

In the last decades urban freight distribution became an important research subject, to answer to a more congested and polluted urban context (Dablanc, 2007). Recent studies have defined and characterized the different movements of urban goods (Ambrosini and Routhier, 2004; Ségalou et al., 2004; Patier et al., 2007; Gonzalez-Feliu et al., 2010a; Russo and Comi, 2011). Urban goods movements present several categories. Two of them are predominant and represent about 90% of the overall urban goods movements (Gonzalez-Feliu et al., 2010a): *inter-establishment supply movements*, which are related to freight distribution between the different activities, and *end-consumer commodity movements*, where the purchased goods are moved by the consumer, related to shopping trips. The remaining 10% contains the city maintenance and construction logistics movements, the waste distribution and a number of small particular activities such as postal services, among others.

Inter-establishment supply movements deal with the last mile of the supply chains. They are studied in-depth in both supply chain management and city logistics research and represents between 35 and 45% of the total road occupancy derived from urban goods movement. End-consumer movements represent about 45-50% but have been less studied since they are assimilated to shopping trips, so to personal trips and not to goods flows. Although nowadays most of these flows are tradition shopping trips, B2C flows start to take a non-negligible part, as they currently represent about 5% of total shopping trips and could represent, more than 15% in 2020 (Georget et al., 2008). In this context, three main strategies are commonly seen in practice:

- *Shopping drive services*, mostly related to peripheral stores and made popular in France by the Auchan group, where customers purchase online and choose the pickup store. Then, they make a car trip to the chosen store where they take their command without waiting queues. Based on the considerations stated by Gonzalez-Feliu et al. (2012), two main trips can be associated to shopping drive: household-shopping trips, which imply big distances in central households, and work-shopping-household trips, which suppose a few increase of the usual

work-household traveled distance (in Lyon[2], the average increase distance is of 3 km per trip, with respect to the 24 km of a household-shopping-household trip associated to a drive service),

- *Home deliveries* that are related to the order-picking strategies defined above. Note that distances of warehouse-based home delivery routes are about 200 km and involve about 40-50 households (Durand and Vlad, 2011), whereas store-based home deliveries involve 10-12 households for an average distance of 50 km (Alligier, 2007),
- *Proximity reception points networks*, where the supply changes consist of including local depots (Augereau & Dablanc, 2008) or using small supermarkets as reception points. In this case, the ordered products are directly prepared in a depot, located in a peripheral area. Then, the command is delivered to a proximity reception point in which they are picked up by the final consumer (Augereau et al., 2009).

2.3. Logistics practices observed by French e-grocery distributors

This subsection provides a synthetic overview of e-grocery development in France. If on-line sales concern almost all business sectors, one has to admit that e-grocery still represents a niche market: its turnover was only, about 1.2 billion euros in 2009 in France. Besides this, currently only about three million French Internet users use on-line supermarkets. This type of sale is attractive firstly for reasons of practicality and of time saving. Consumers want to save time during food purchasing in two ways: (1) on going to the store by reducing (or even by eliminating) their round trip time and, also, the time of spent looking for a parking space; (2) du-ring their time in store by eliminating waiting times at food preparation counters and at the checkout. Internet users underline the practicality of on-line sales, also in two ways: (1) on-line stores are continuously open, 24 hours a day – therefore this scenario allows transactions at any time of the day; (2) on-line orders can be directly delivered or dropped off at pick-up points. Let us add that the consideration of environmental problems also seems to push households to develop their Internet purchases: the environmental impact seems rather positive because of the reduction of movements and of GHG.

The cost of this service seems to constitute the major obstacle to e-grocery development because, in the mind of many French people, on-line

[2] Statistics from the National Household Personal Trip Survey of the Lyon urban area (Sytral, 2006).

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; either the price of articles is situated at the same level as that practiced in store and it is advisable to add to this the logistic service costs. Less sensitive to this cost than the other SPC (Socio-Professional Category), the SPC+ (upper SCP) is also, at the moment, the category the most attracted by e-grocery: more half of their food expenses would already be made in cyber-markets, while the offer, a real element of differentiation between e-grocers, is particularly reduced with only 7,000 references on average, compared to 40,000 for a traditional supermarket. Finally, to present the main French logistics practices in e-grocery distributors, four main actors have been selected: Auchan, Carrefour, Casino and Intermarché. The simulations will then be based on their distribution strategies and logistics models.

- **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, whilst sticking with 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).
- **The Ooshop distribution schema:** *Ooshop* is the e-grocery division of *Carrefour* in France. *Carrefour* is one of the most important grocery distribution groups in the world and the first in Europe. Because of its big size and the spread spatial distribution of its platforms, *Carrefour* has decided to create a separate company, *Ooshop*, which manages online sells. Non fresh products are stored and managed on a national e-commerce platform, from what they are distributed into local platforms, which are not only used to e-grocery but have a specific section to this business field. These platforms are in general located near gross markets in big urban areas. Then, a specific logistics provider, Star's Service, specialized on home deliveries, collects the commands and completes them with fresh products from the local gross market. Then, home delivery routes are made to deliver customers. This system needs the customer to command at least with 1-2 day anticipation in order to ensure the entire logistics process.
- **The Cdiscount system:** Analogously to *Ooshop* and *Carrefour*, Cdiscount is the e-grocery division of *Casino* group in France. *Casino* is smaller than *Carrefour* but presents a much expanded network of prox-

imity supermarkets: the *Petit Casino* network (traditional small supermarkets) and the *Spar* and *Vival* networks (proximity stores that are open until 9-11 p.m., the closest to the 7/11 group that can be found in France). This structure allows the *Casino* group to propose a reception point e-commerce service, which works as follows. Commands are prepared on a regional platform, and then they are delivered to the chosen reception point. The customer can pick-up his or her command at any hour (respecting of course the store's opening hours). Because the density of these networks is high in big cities, this schema can be competitive if its usage rate increases in the next years.

- **The *Expressmarché* logistics model (Intermarché):** Pick-up directly in store, an alternative to store-picking, seems to have convinced the most hesitant French distribution brands. It is in particular the case of Intermarché, whose will is to control its logistic costs (the main reason behind this choice). It is, therefore, on 300 supermarkets that *Expressmarché*, the cyber-market of the grouping, leans today. *Intermarché* has chosen to take advantage of the density of its network (a selling point every 18 km). If HD can also be envisaged because of this very good territorial cover, *Expressmarché* was also made available on its two pick-up alternatives: the classic in store pick-up and the drive-through, which means that Internet users do not need to alight from their vehicles.

3. Impacts of B2C trends on e-commerce: a scenario assessment approach

In this section, an assessment of several distribution scenarios related to e-grocery development, based on the four models described above is presented. In order to isolate the effects of e-commerce from other effects, such as population growth or changes in retailing demography, the scenarios are built from a reference by changing only the organizational schemas of B2C distribution (with the respective changes in the overall supply chain if applicable). For each hypothesis, a quota of 15% of e-commerce users is supposed, in order to simulate a near future situation, according to Georget et al. (2007).

In order to define a reference situation authors have selected a significant urban area where statistical results concerning population, establishment and shopping trip trends are available. More precisely, the urban area of Lyon is chosen. This city and its surroundings represent the second metropolitan area in France, for which recent data is available (2005-2006).

This area represents about 2.000.000 inhabitants and 800.000 households. The main data sources are an extract of the register file of companies (SIRENE file) of the chosen area, the corresponding census database (INSEE file), and the 2006 personal trip survey, which follows a French standard (Sytral, 2006).

The proposed scenarios can be grouped in two sets. The first set (S1-i) contains four single scenarios each of them derived from the generalization of a sole logistics model. Then, a second set (S2-i) of scenarios results from the combination of these four logistics models in two different combinations: the first corresponds to current practices, and the second to a more systemic approach where each zone privileges the distribution channel that meets better its needs, including in terms of environmental and social impacts (Routhier et al., 2009). In any case, the usage rate of e-commerce is set to 15%, taking into account Georget et al.'s (2007) considerations. Concerning the distribution of shopping practices, the assumption that e-grocery user profiles are the same that traditional shopping is made. Indeed, the categories of e-commerce shoppers proposed by Rohm and Swaminathan (2004) are similar to those of French households for traditional shopping (Van de Walle and Rivoire, 2005). This assumption will be able to define the usage rates of each distribution channel. The four single scenarios are defined as follows:

- S1-1: An "**Expressmarché model**" 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 will cover small routes from all locations within the urban area, whereas big stores will use peripheral stores as the starting point of longer routes. Two types of services are proposed: store-picking services and home deliveries. Concerning store-picking, household behavior is assumed to be similar to that of traditional shopping. Regarding home delivery routes, they are supposed to be similar of those defined by Alligier (2007) from specific surveys (vehicles of an average total weight of 2.5 that deliver 10 households making a distance of near 50 km). In this scenario, all retailers are supposed to offer B2C services.
- S1-2: An "**Auchan direct**" scenario. This hypothesis supposes that only home deliveries are allowed, following a warehouse-picking schema. This supposes the use of a regional depot (about 50 km from the city center), with the changes that this structure suppose on the global supply chain. Indeed, the quota of e-grocery is subtracted to traditional supply flows and affected to these regional depots. Then, light goods vehicles

(3.5T) are used to deliver an average of 50 households per route (Durand and Vlad, 2011). The total traveled distance is in average 200 km per route. This scenario supposes that only large e-grocery groups are proposing these services.

- S1-3: An "**Ooshop**" scenario. This scenario is similar to S1-2 but differs in the location. Local platforms are located in far peripheral areas (about 20 km from the city center), then, light goods vehicles (3.5T of total weigh) make home delivery routes each of them servicing about 25 households and travelling about 120 km (TL&Associés and LET, 2009).
- S1-4: A "**Cdiscount**" scenario. This scenario supposes a high network of reception points supported by peripheral platforms. Goods are transported from the corresponding platform to assigned reception points from the same regional platforms that traditional retailing supply, but using a specific fleet of small trucks (about 7T of total weight). Then, customers pickup the purchased products on food or by car, making very small trips in both cases. The shopping trip behavior of households picking up the purchased products at proximity reception points is supposed to be the same as traditional shopping at proximity small supermarkets (Van de Walle and Rivoire, 2005).

The two combined scenarios derive from the combination of S1-1 to S1-4 and can be defined as follows:

- S2-1: A **business as usual situation**. In this scenario, an e-grocery usage rate of 15% is assumed, with a distribution that follows current trends. To do this, a current model is associated to each concerned store, i.e. for each grocery retailer located in each zone of the concerned urban area, an e-grocery model is assigned. Very small retailers or stores that manifested not to be proposing these services are supposed to not propose e-grocery alternatives in the current simulation. The distribution rates are fixed as follows: 10% *Expressmarché*, 30% *Auchandirect*, 40% *Ooshop*, and 20% *Cdiscount*. Concerning the geographical distribution of these services, *Cdiscount* is spread in all the area, but more concentrated in town centers, whereas *Auchandirect* and *Ooshop* serve all the zones. *Expressmarché* is more developed in the near periphery (the close surroundings of the main city).
- S2-2: A second mixed scenario that takes into account **best practices** for each channel and finds the synergies between these channels. This is a hypothetical situation that however is applied under realistic conditions: the enterprises are in competition, and no collaborative strategies between competitors are envisaged. Only internal collaboration to optimize each enterprise's resources is considered. The distribution rates are fixed as follows: 10% *Expressmarché*, 25% *Auchandirect*, 25% *Ooshop*,

and 40% *Cdiscount*. Moreover, the geographical distribution of these services is made to decrease the traveled distances of B2C flows and shopping trips. More precisely, *Expressmarché* and *Cdiscount* are more developed in the main city and its close surroundings (35-40% of the total population) whereas *Auchandirect* and *Ooshop* serve the peripheral zones.

In order to simulate these scenarios, authors adapted the simulation procedure proposed by Gonzalez-Feliu et al. (2012), which chart is shown in Figure 3. Three existing tools are used to obtain the basic inter-establishment movements and traditional purchasing flows. Through FRETURB model (Routhier & Toilier, 2007), last mile flows that deliver or pick-up retailing activities are estimated. Then, a shopping trip model (Gonzalez-Feliu et al., 2010b) is used to estimate shopping trip flows. Finally the substitution procedures described by Gonzalez-Feliu et al. (2012) are used to estimate the impacts of e-grocery distribution in terms of road occupancy rates, expressed in km.PCU (private car unit[3]).

[3] PCU are standard road occupancy rates in France. The conversion rates are the following:
1 car = 1 PCU; 1 light goods vehicle = 1.5 PCU; 1 small truck = 2 PCU; 1 big truck = 2.5 PCU; 1 semi-articulated truck = 3 PCU

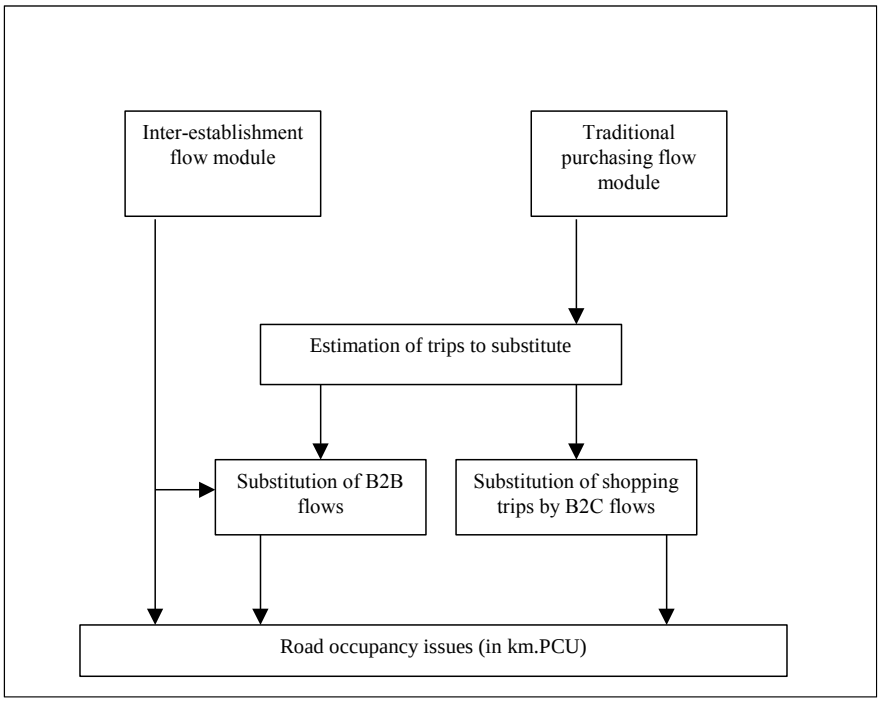

Fig. 3. Integrated simulation procedure chart (adapted from Gonzalez-Feliu et al., 2012)

The simulation of all the scenarios led us to propose a set of results which are reported in Table 2. The first column contains the identification of each scenario. Then, the road occupancy issues are estimated respectively for last mile B2B flows, B2C flows and shopping trips. Finally, the total road occupancy rates for all the flows are presented. Authors chose to not present all the B2B flows but only the last mile, assuming that all the organizational changes have an impact only on urban and peri-urban flows, so on last mile transport. Note that the reference scenario produces nearly 8.3 millions of in the Lyon urban area and that, in 2006, the downstream delivery flows were considered negligible. The road occupancy rates are extremely related with greenhouse gas emissions. More precisely, the proportionality between these two measures is shown in Routhier et al. (2009), where the impacts of shopping trips and lights goods vehicles are similar for both measures (in the reference situation of our scenarios, these trips represent 11% of the total road occupancy by moving vehicles (passengers and goods) of the urban area in Lyon and 11% of the greenhouse

gas emissions, in tons of CO_2-equivalent emissions[4]). Moreover, a decrease on traveled distances and road occupancy has a direct impact on pollution, independently of the technological solutions (Gonzalez-Feliu et al., 2012).

Table 1. Simulation Results for the Lyon urban area, in millions of km.PCU and in percentage difference with respect to the 2006 situation

Scenario	Last mile B2B flows	B2C flows	Shopping Trips	Total
S0	**0.39**	**0.00**	**3.94**	**4.33**
S1-1	0.36	0.26	3.55	4.17
S1-2	0.31	0.41	3.35	4.07
S1-3	0.33	0.28	3.35	3.96
S1-4	0.34	0.12	3.38	3.84
S2-1	0.35	0.26	3.41	4.02
S2-2	0.35	0.24	3.21	3.80

Scenario	B2B flows	B2C flows	Shopping Trips	Total
S1-1	-9.0%	6.7%	-9.8%	-3.7%
S1-2	-20.2%	10.5%	-15.0%	-6.0%
S1-3	-16.8%	7.1%	-15.0%	-8.5%
S1-4	-14.6%	3.1%	-14.1%	-11.3%
S2-1	-12.3%	6.5%	-13.4%	-7.2%
S2-2	-12.3%	6.1%	-18.6%	-12.2%

It can be observe that scenario S1-1, which mixes HD and pick-up services, has a limited effect on road occupancy reduction (less than 4%) because of their location and geographical distribution (there are not enough proximity structures to ensure an efficient system). Scenario S1-2 shows the advantage of using specific platforms, which can be justified in medium-sized urban areas (from 500 000 to 3 000 000 inhabitants). More-over, avoiding store-picking for end-consumers implies a consequent reduction of shopping trips road occupancy rates (about 15%). However, B2C flows increase, and due to the vehicles used, which are bigger than private cars, this increase compensates a part of the reduction obtained for shopping

[4] Equivalent CO_2 takes into account the proportions of CO_2, CO, HC, NO_X and SO_X emissions, and their contribution to greenhouse effect (Routhier et al., 2009).

trips. Furthermore, B2B flows representing less than 10% than end-consumer's flows, the big gains for these flows are not enough to compensate the increase due to B2B flows. However, the overall gains in terms of road occupancy reach 6%, almost the double that S1-1.

In this sense, scenario S1-3 shows the interest of using existing platforms for e-commerce with dedicated logistics schemes. However, the differences remain small (about 2.5% of difference in the total road occupancy rates), because of the hypothesis of e-grocery usage (15% of the total demand), so an overall reduction of 8.5% in terms of road occupancy. However, scenario S1-4 is the most advantageous of all single scenarios. Indeed, it results on a reduction of shopping trips of about 14% (i.e. near 1% less than S1-2 and S1-3) with a contained increase for B2B flows (about 3%) and a reduction of B2B flows also close to than S1-3 (about 14%), with a total impact translated on a reduction of near 11.5%.

If all these scenarios are combined following current practices (S2-1), it can be observed that nowadays there is not synergy logic and that each company develops its system without a "city logistics" viewpoint. This results on a total reduction of about 7%, which is close to S1-2. Only home delivery models being based on peripheral or non-urban platforms and city centers being congested several hours per day, it seems to favor proximity deliveries in the central zones and to give home delivery service to peripheries. For this reason, scenario S2-2 seems more favorable. To obtain an overall reduction of more than 12% it seems important to better combine the four alternatives. Although all alternatives operate in all the urban area, households privilege proximity reception points and proximity deliveries (simulated separately in S1-1 and S1-4) in the main urban area and in the near periphery. Moreover, home deliveries are privileged in the peripheral areas of the main city and in all the surroundings, avoiding to enter the city center for this home delivery vehicles, which are bigger that those of proximity home deliveries. More precisely, this scenario leads on a reduction of almost 20% of the shopping trip road occupancy rates with about 6% of increase for home and proximity deliveries.

4. Conclusion

This chapter presented an overview on the latest developments in e-grocery distribution and presented a scenario analysis using an empirical simulation approach. Four single scenarios, each of them related to a logistics model proposed by French e-grocery retailers are presented and simulated. It is shown that each single scenario has advantages and disad-

vantages to serve the different locations of the city. More precisely, scenarios S1-2 and S1-4 are more efficient in town centers and very populated and dense areas (both in terms of households and proximity retailers) because they are based on proximity retailer networks. Home deliveries (S1-2 and S1-3) are more efficient in household dense areas without a good proximity retailer density, i.e., in non central city areas and in near periphery surroundings. Because of logistics platform's locations, these two models are better than the other two for far periphery e-grocery distribution (proximity reception points or retailers are more spread in far peripheral zones).

Combined scenarios assessment shows that current practices (S2-1) do not profit of the synergies between each logistics model, leading to a total reduction of about 7% in terms of road occupancy, which is the third lowest impact. A better combination taking into account these possible synergies (S2-2) leads to an overall reduction of more than 12%. However, this scenario supposes that each company develops more than one logistics models, which can be difficult for co-operative and small stores like *Intermarché* and other franchising-based distribution companies.

Finally, authors have to note that in this simulation assumes development trends of e- commerce, which are realistic but remain still contained (15% of the total demand). According to Gonzalez-Feliu et al.'s (2012) results, and using the same simulation tool, it can be stated that a wider development of e-grocery will lead to a reduction of about 30-40% for road occupancy, on an hypothesis of 50% of e-grocery in urban areas).

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