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Abstract

IN France, e-commerce has experienced steady growth over the past decade. A striking aspect is that it is now widespread among different segments of the population, including suburban and rural households. This growth has generated significant demand for dedicated delivery services to end consumers. Pickup points (PP) as alternatives to home delivery represent a fast-growing solution, accounting for about 20% of parcel deliveries to households. The article focuses on the strategy of PP network operators. Our results are threefold. We have documented the recent development of alternative parcel delivery services to e-shoppers in Europe, and especially in France. We have described how the operators have decided to organize their PP network, identifying main variables and constraints. We have provided an analysis of PPs spatial distribution in France. The paper shows that at the French national level, PPs are now well established alternatives to home deliveries and their presence covers urban, suburban and rural areas. While PP density in remote areas decreases faster than population density, rural e-consumers' accessibility to PP sites has reached a viable level. Furthermore, PP delivery services generate new types of B2B freight trips that are not yet included in current urban freight models.

INTRODUCTION

As in many European countries, shopping habits in France are changing fast. E-commerce is becoming increasingly common due to the spread of IT systems such as laptops, tablets and smartphones. In 2012 e-commerce accounted for 7% of the French retail market (excluding food), i.e. €45 billion, with revenue up by 19% compared with 2011 (FEVAD, 2013). Interestingly, a few authors (Moati, 2009) have reported that online shopping has become widespread among the different segments of the population whether they live in central, suburban or even rural areas, although this change has not been documented in a comprehensive manner. Over the past ten years, the spread of online shopping has generated significant demand for dedicated delivery services to the end consumer. This has resulted in the increasing fragmentation of shipments in the "last mile" as the final segment of the supply chain is known (Esser, 2006; Schewel and Schipper, 2012). Currently, in France, the vast majority of the 300 million parcels generated annually by distance selling result from online shopping (ARCEP, 2011).

Consequently, e-commerce increases the challenges facing product distribution, with direct effects on logistics systems in urban and suburban areas where traffic congestion and accessibility are crucial factors. In the case of the business to consumer market (B2C), home deliveries constitute the most problematic solution in terms of service costs and organization (Song et al., 2009). Although home deliveries are usually preferred by online shoppers (CREDOC, 2010), we are seeing the development of alternative solutions which satisfy both consumer demand for flexibility and firms' need to optimize parcel distribution through consolidated shipments. In Europe, automated parcel stations (APS) equipped with lockers, and pick-up points (PP), which are stores providing parcel drop-off and pick up, are fast-growing solutions. These two end-delivery options are playing a decisive role in the reorganization of commercial and logistics activities (Augereau and Dablanc, 2008) and are

becoming key features of the strategy of e-commerce and transport players. In the US, the online giants Amazon and Google (Google has opened an internet sales platform based on Amazon's market place) recently decided to invest in their own branded locker box solutions and are in the process of deploying pilot pickup/drop off sites. Similarly, in France new players are constantly emerging and new partnerships being set up, such as the takeover of the Kiala PP network by UPS in February 2012, and the takeover of the Pickup Services PP network by the French company La Poste, via its subsidiary GeoPost in 2009.
Currently, in Europe, the largest APS network is the Packstation network operated by DHL/Deutsche Post in Germany (2500 locations around the country). Locker box networks have a limited presence in France, as witnessed by the very small network of 33 kiosks run by La Poste under the name of Cityssimo. New operators such as ByBox (originally from the UK) are likely to extend these services in Europe in the coming years. The second alternative, which forms the focus of this paper, is PP networks. In France, four competing providers are growing rapidly and managing increasingly large volumes of parcels. These operators - Mondial Relay, Relais Colis, Kiala and Pickup Services - have developed standardized delivery solutions for the whole country and in 2013 each of the networks provides access to a pickup point in under 10 minutes by car or on foot (depending on the area) to 90% of the French population. Today in France, more than 20% of shipments resulting from online shopping are delivered through a PP instead of at home.

PROJECT OBJECTIVE

Purpose of study

The aim of this study is to provide a better understanding of recent developments in urban freight logistics for alternative parcel delivery services to e-shoppers. Our work is part of a broader research program (2012-2015) that looks at disparities in access to e-commerce and home deliveries among urban, suburban and rural residents in France (Motte and Belton, 2012). The investigation deals with PP service providers and it depicts the structure of French PP networks design and delivery strategies. It provides an analysis of the locational patterns of PP networks and assesses disparities of access to PPs in urban, suburban and rural areas, the Seine-et-Marne department (area at the East side of Paris).

The case study is the Seine-et-Marne department, partially integrated within the Paris metropolitan area (East side) urban and suburban settings, but it also has some rural areas, providing an interesting example of diverse residential environments and enabling comparisons. A final objective of this work is to provide directions for future research looking at the impacts of e-commerce on mobility and city logistics. Identifying some of the variables related to parcel flows within PP networks can help us better understand and plan for the traffic generated by city logistics.

COMPOSITION OF THE PROJECT

Definition of the subject

Previous research on end-delivery movements for e-commerce has mostly focused on describing and modeling household shopping trips (Crainic et al., 2011; Gonzalez et al., 2012). In particular home delivery, the core business for shippers and couriers, has been thoroughly investigated during the last decade (Browne, 2001; Punakivi, 2001; Visser et al.,

2013), as has grocery shopping (Cairns, 1997; Wygonik and Goodchild, 2012). However, with regard to e-commerce delivery schemes, little is known about proximity reception points and site location criteria, trip chain patterns, and tracking and tracing ICT tools. Song et al. (2009) investigated the effect of failed deliveries, estimating customer traveling costs and the environmental costs of home delivery against potential PP networks based on post offices, supermarkets and railway stations across West Sussex in the United Kingdom. In France, the topic has barely been studied.
Although lockers networks seem to be a promising solution, reducing missed deliveries and allowing for off-hour logistics operations, but at some important investment costs (Augereau and Dablanc, 2008), the main focus of this analysis is on the PP solution, due to the fact that limited number of parcels are handled by APS schemes in France.

Review of current trends

Two major alternatives are identified for e-commerce final deliveries: (i) pickup points (PP) and (ii) automated lockers. PP networks operate through local shops where packages generated by the distance selling market are dropped off for collection by their individual recipients. In general, PPs are attended six days a week, during the opening hours of their host business (dry cleaners, florists, etc.). The second category refers to networks of APS, where people can withdraw packages 24 hours a day from locker boxes usually located in shopping centers, gas stations, train stations or on the street. The strength of both systems is the flexibility of opening times compared with post offices, giving consumers the option to withdraw their packages at the time that suits them, as well as the lower costs for transport providers compared with home delivery. Moreover PP and APS networks include powerful IT tools for tracking parcels and managing returns, and international partnerships are set up for cross-border delivery.

Main drop off networks in Europe today

Alternative delivery networks have recently developed in all European countries, especially in northern Europe (the Swedish operator PostNord provides about 5,000 distribution points to the end consumer in Sweden, Norway, Finland and Denmark), the UK, France and Germany, where e-commerce and delivery services are more mature than in the rest of Europe. The United Kingdom, Germany and France have Europe's biggest online markets, which together represent 71% of e-commerce with revenues amounting to €143.2 billion euros in 2011 (Kelkoo, 2012). Between 10 and 20% of shipments are delivered through a PP or locker solution. Table 1 gives a glimpse of the recent progress of selected European PP/APS networks in these three countries, with growth rates ranging from 5% to 150% since 2008.

The French PP model

The trend towards an intensification of the networks has been confirmed in France, where the aggregate number of ventures serving as PP rose from 10,900 in 2008 to 18,200 in 2012, i.e. an increase of 67%. The French system of point relais (reception-points) has atypical features, such as its early development, which began 30 years ago to manage mail-order deliveries, and the large number of players, with different shareholding structures. As presented in the introduction, there are four competing PP network operators in France

TABLE 1. Trends for reception point networks in Europe

Company	Service type*	Country	No. sites 2008	No. sites 2012	Growth rate 08-12	Parcel volumes 2012
ByBox	APS	UK	1,000	1,300	+30%	N.A.
Collect Plus	PP	UK	Not available	5,000	N.A.	N.A.
PackStation	APS	Ger.	1,000	2,500	+150%	N.A.
Paketshop (Hermes)	PP	Ger.	13,000	14,000	+7,7%	N.A.
ByBox	APS	F	Not implemented	170	N.A.	N.A.
Cityssimo	APS	F	20	33	+55%	N.A.
Kiala	PP	F	3,800 (with M.R.)	4,500	+18%	15 million
Pickup Services	PP	F	3,100 (à2pas)	5,200	+68%	9 million
Mondial Relay (Point Relais)	PP	F	3,800 (with Kiala)	4,300	+13%	12 million
Relais Colis (Sogep)	PP	F	4,000	4,200	+5%	23 million

* APS = automated pack station; PP = pickup point
Source: the authors with company data from various sources

(Mondial Relay, Kiala, Relais Colis and Pickup Services), with rather equal network development (see below). These providers are medium-sized, whereas in other countries, the market is usually dominated by one or two big operators (e.g. Hermes in Germany, almost the only PP network operator there, in parallel with DHL Packstations as APS). The initial rise of PP operators in France derives from the development of mail-order selling during the 1980s (Augereau et al., 2009). Sogep – known as Relais Colis – and Mondial Relay were created by two mail-order companies, respectively La Redoute and 3Suisses, with the aim of improving efficiency in shipping services. These operators expanded their networks during the 1990s, driven by a sequence of postal strikes, and they are now among the biggest players on the French market. The spread of e-commerce opened the way for two additional PP companies, the Belgian firm Kiala and Pickup Services, a French start-up created in 2004. The rise of these companies has not gone unnoticed by the major delivery and transport players, such as UPS and La Poste, which have shown particular interest in the IT system and e-logistics data networks set up by the two firms. As mentioned earlier, UPS and La Poste bought Kiala and Pickup Services respectively.

Figure 1 shows that the four current networks primarily rely on small independent local shops, as florists, bars, tobacco shops and press kiosks. These networks have a quite similar spatial deployment and standard of service across France. Each of these operators provides online shoppers with a network of between 4000 and 5500 pickup points across the country, namely almost one fourth of the Postal offices network. In 2010, about 60 million parcels were delivered in France via PPs, i.e. approximately 20% of the total volume of parcels generated by distance selling.

FIGURE 1. Type of partner store in pickup points network, Seine-et-Marne

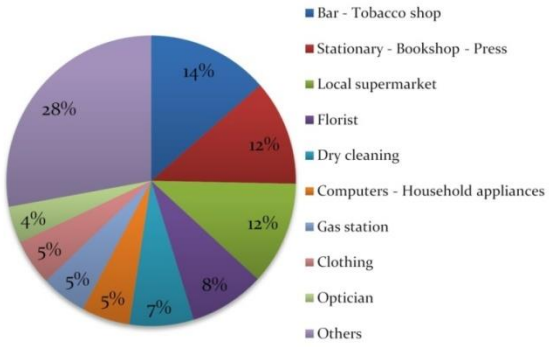


Table 2 presents changes in the density rate of PP per network, showing how it increased for the whole French population between 2008 and 2012; however, due to the constant growth of e-commerce, it is important to point out that each PP site is now serving a larger number of online shoppers.

TABLE 2. Pick-up point density over population and e-shoppers, France 2008-2012

Nom	**PP per 100,000 inhabitants 2008**	**PP per 100,000 inhabitants 2012**	**PP per 10,000 e-shoppers 2008**	**PP per 10,000 e-shoppers 2012**
Kiala	6.1	7	1.7*	1.4
Pickup Services	5	8.1	1.4	1.7
Point Relais (Mondial Relais)	6.1	6.3	1.7*	1.3
Relais Colis	6.4	6.6	1.8	1.4
Average	5.9	7	1.6	1.5

* Mondial Relay and Kiala shared the network until 2012.
Source of data: from interviews, and from FEVAD and INSEE 2013.

The continuing influx of newcomers to the end-delivery sector shows that the market has not reached saturation. In 2012, for example, the retailing chain Casino Group created an ad hoc reception service for CDiscount, a household appliance e-retailer. This network is hosted by the convenience stores belonging to the group and benefits from flows that are integrated into the inventory management system used by Casino outlets. Other retailers provide PP option in their own outlets, such as Darty and most of the main retailing chains (Carrefour, Auchan, Monoprix, etc.), in particular grocery retailers, increasingly provide "Drive" services, a pick-up solution at the store after online grocery shopping.

Discussion of why it deserves attention

According to the European Commission Green Paper on the parcel delivery market for e-commerce (2012), the growth potential of reception point delivery systems in the European Union is strong. It is probable that in the near future, drop-off and collection schemes will account for a significant share of parcel volume and will evolve into a more structured distribution channel, affecting urban logistics practices and enhancing competitiveness. The

rapid development of alternative solutions for parcel distribution is confirmed by reports and studies dealing with trends affecting the internet economy and consumer shopping behaviors (Nemoto et al., 2001; Rallet and Perrin-Boulonne, 2010; Bourdin, 2012).
Deliveries to end-consumers for B2C operations present many challenges, such as missed and highly fragmented deliveries. PP networks make it possible to change from B2C deliveries to less costly B2B deliveries: PPs reduce the risk of missed deliveries and improve shipment consolidation. This explains their very considerable increase in France and Europe during the past five years. However, PP delivery services generate new types of B2B freight trips, which are not yet included in current urban freight models.
This investigation lays the basis for further research focused on the identification of explanatory factors for freight and passenger trip generation in urban and metropolitan areas. It could also help those modelling city logistics traffic to better integrate the effects of e-commerce.

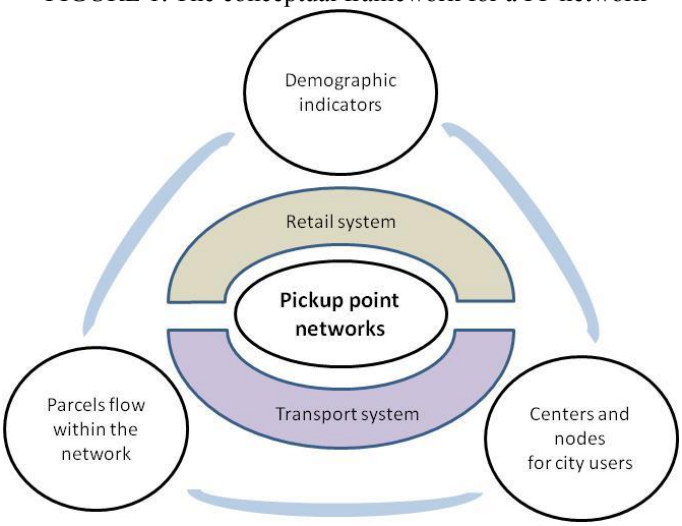
RESEARCH APPROACH

Conceptual framework

Our exploratory research took place in 2012-2013. We began by drafting a conceptual framework to outline the main factors which guided our investigation of the features and spatial patterns of PP networks, according to the operators' point of view. A graphic representation of the conceptual framework is presented in Figure 1. The model consists of six elements. Center circle Pickup Point Networks represents the process of deployment lead by the operator, which is inclined to enlarge the network with additional sites. The main hypothesis is that PP network growth is influenced by external and internal factors such as population density, proximity to transportation nodes and socio-economic centers, and the distribution of parcel flows throughout the network. These factors, which are identified as the key elements of PP strategies, are represented by circles connected by two directional arrows due to their strong interactions. Circle Demographic indicators represents the concentration of consumers, as it is assumed that higher population density generates higher demand of deliveries services. One of the variables that represent the demographic context is thus population density. Similar variables that represent employment rate, computer ownership, Internet access and level of use are usually included in the assessment process. Circle Centers and nodes for city users represents parameters related to end-consumers' mobility and accessibility to socio-economic activities, in particular end-consumers' use of both public transport and private cars, and the density of retail outlets and commercial services, business and employment sites, cultural and leisure centers and public transportation nodes, i.e. bus stops and regional railway stations. The third circle, Parcel flow within the network, represents volumes of parcels in each site and provide information on preferences of receivers throughout the selected geographical zone. This factor is useful to evaluate the strategic value of locations and prevent saturation of the local PP network. Although it provides important insights into their performance, the data relating to this indicator are held by the PP network operators who consider it to be confidential.
The deployment of PPs is subject to two main constraints, pertaining to the retail and transport systems, represented by two semi-circles. With regard to the design of a PP network, retail activities play key logistics functions as they permit the reception, storage and delivery of parcels. The availability of retail activities and willingness of shop-owners to

enter a PP network are therefore vital for successful network design. Indeed, as there is a risk of a PP becoming overloaded, in very busy areas PP operators are already competing with each other to find new shops to add to their networks. If the volume of parcels increases further, networks could reach saturation level. Additional constraints relate to the transport system, and affect the urban freight system as a whole. Roads, parking lots and public transport networks and services directly influence the development and performance of delivery services that use PPs, therefore the transport system and the available infrastructure are indicated as a potential constraint that affects the strategy of network operators.

FIGURE 1. The conceptual framework for a PP network



DATA

Our investigation combined a qualitative approach, based on a literature review and survey activities, with a spatial analysis of PP localization. These two methods provided complementary but converging results. They provided a more comprehensive picture of the variables affecting PP delivery schemes and a verification of intermediate findings.

The qualitative research set out to collect data on the existing e-commerce parcel delivery system from the various stakeholders in the transport and retail systems, including web-retailers, shippers, the French public postal operator, logistics providers, PP network operators and PP partnering shop-owners. It included an analysis of official documents, academic and consulting studies, trade press articles and reports on postal activities and e-commerce. Data on PPs were collected from the literature and PP network operators' websites, as the official statistics are limited.

As reported in Table 3, seventeen individual face-to-face interviews were conducted using semi-structured questions (dealing with the nature of delivery services, ICT tools and operational processes, and delivery demand/supply in urban, suburban, exurban and rural areas). The respondents were selected among the largest transport and retail operators providing home delivery and alternative delivery services in France. The survey also involved administering questionnaires to a small sample of PP partnering shops – four for each PP network operating country-wide. The purpose of the questionnaires was to collect

information on the last part of the delivery process, and to identify the mechanisms of last mile operations for PP services, in particular from small retailers.

TABLE 3. E-commerce parcel delivery system survey

Sector	Service	Activity	Type of survey	#
Transport system	Reception points delivery services	Companies managing PP and APS networks	Interview	4
	Home delivery services	Shippers, carriers, postal operator, logistics providers	Interview	6
Retail system	Commercial activities	Shop-owners hosting PP	Questionnaire	16
	E-commerce	Web-retailers, brick and mortar retailers, trade associations	Interview	7
			Total	33

The second phase of the investigation focused on a geospatial analysis of the four PP networks and an assessment of population accessibility within Seine-et-Marne, comparing urban, suburban and rural areas, using the categories defined by the French National Institute for Statistics and Economic Studies (INSEE). The selected areas were defined as follows:

- An *urban area* is a set of municipalities made up of an urban centre with more than 10,000 jobs, where the distance between buildings is equal to or less than 200 meters;
- A *suburban area* is a residential area within commuting distance of an urban centre and connected to it by public transportation and main roads;
- A *rural area* is any of the small urban units and rural municipalities outside urban and suburban areas.

The approach we adopted in order to analyze locational factors and strategies was to use spatial data and descriptive statistical variables, including nearest-neighbor statistics. We used the digital spatial database of Seine-et-Marne (August 2012) provided by the Ile-de-France Institute of Planning and Urbanism (IAU). The accessibility measure took account of access distance and time for the population, where access distance was calculated using the Euclidean distance from the centroid of each municipal zone to the nearest PP site in the four networks, and access time was calculated using the shortest journey by car on non-congested routes from the centroid of each municipal zone to the nearest PP site in the networks. Once travel time had been computed for each relationship, we compared the access time for urban, suburban and rural municipalities, weighted by population using data for 2009.

ANALYSIS AND RESULTS

Location as a strategic issue for efficient PP networks

To illustrate the mechanisms of PP networks location, it is useful to identify the core idea of the firms' business model. Their economic viability relies on the capacity of the network to attract and manage a sufficient volume of goods, in order to reduce the unit cost of delivering parcels and the proportion of fixed costs generated by the structure, seeking to achieve economies of scale.

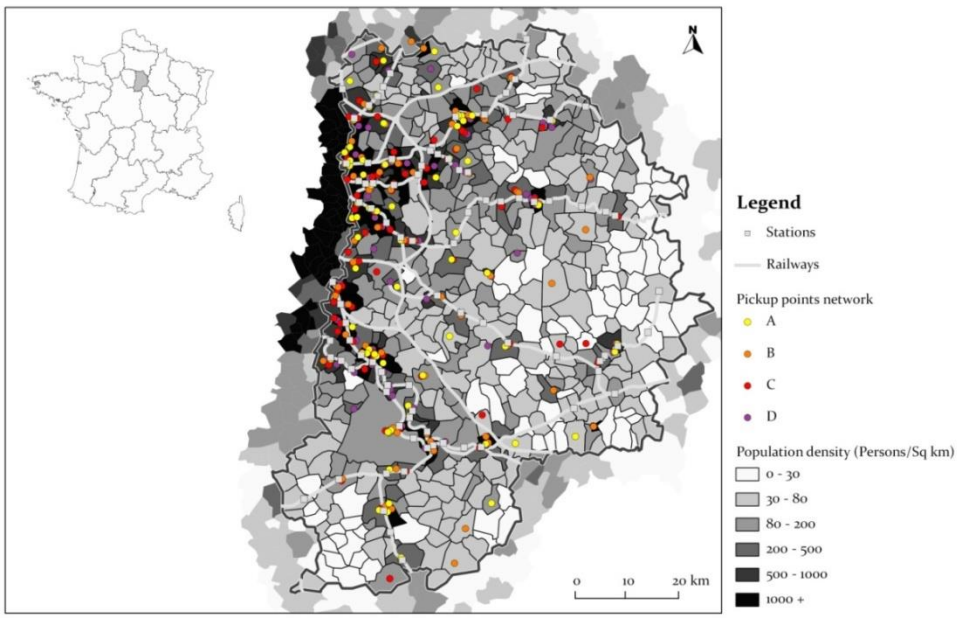
The increase in flows, a primary target, must be backed by a capillary network large enough to serve online shoppers in each area. In fact, there is a risk that distribution concentrates at certain PPs to the detriment of others that are less strategically located or less easily accessible. So while delivery consolidation helps to increase the productivity of a pickup point, the flow of parcels must be appropriate to the size of the business hosting the reception point in terms of storage space and time taken up by parcel handover. Therefore the location scheme adopted by the provider must have the scope to maintain a balanced flow and achieve uniform performance in a network that must remain as stable as possible.

PP location and distances

In order to assess the deployment of PPs in different types of urban, suburban and rural environments in France, we took the Seine-et-Marne Department as a case study. It is located in the Eastern part of the Paris region, with a population of 1.3 million and 440,000 jobs. Seine-et-Marne covers 6,000 square km, in which farmland accounts for 56%. Population has tripled over the past 50 years and density across the area tends to vary substantially. Due to Paris urban sprawl, the western parts of Seine-et-Marne are far more densely populated than the eastern and southern suburbs, where rural areas are significant. Densities also follow the three main regional railway lines.

The Paris region, featuring the highest demand for parcel deliveries in the country, has high standards for delivery services including 24 hours and "same day." The demand for shipping services has generated a dense PP coverage in Seine-et-Marne: the four French PP companies cover the Department with an aggregate of 391 parcel reception points. Each network offers a wide frame of PPs, ranging from 70 to 134 sites each. As shown in Figure 3, the PPs are numerous in the western side of the Department, belonging to the Paris conurbation, where population densities are higher than 1000 per square km. More precisely, within the whole Department, PP distribution patterns show a significant positive correlation with population density, with a predictable decline in PP density in rural areas.

FIGURE 3. Pick-up points network in Seine-et-Marne, 2012



Map by F. Fortin, IFSTTAR

At the aggregate level, we observe that the PP networks present similar locational patterns and tend to target the same areas, i.e. the most populated areas, where there is a very large number of potential partnering shops. The clustering trend is further evidenced by the dispersion index which ranges between 0.56 and 0.93 for the four PP networks. As expected, distances to the nearest PPs vary significantly: on average, the population is located 1.6 km from the nearest PP in urban areas, and 6 km in rural areas. No major differences are observed among the four networks. Discrepancies between urban and rural areas confirm the importance of car dependency issues for rural population, while urban consumers are more likely located at a walking distance from the PP.

It is also noteworthy that a large number of PP sites are located near commuter railway stations: one station out of two in Seine-et-Marne is within a 300 meter range from a PP. As shown in Figure 3, 51% of PPs are located within 400 meters of a station and there is a PP within 600 meters for each regional railway station. Therefore, railway stations, which serve as functional nodes and transit point for commuters in Paris's conurbation, are targeted as priority sites to recruit stores to be included in the network.

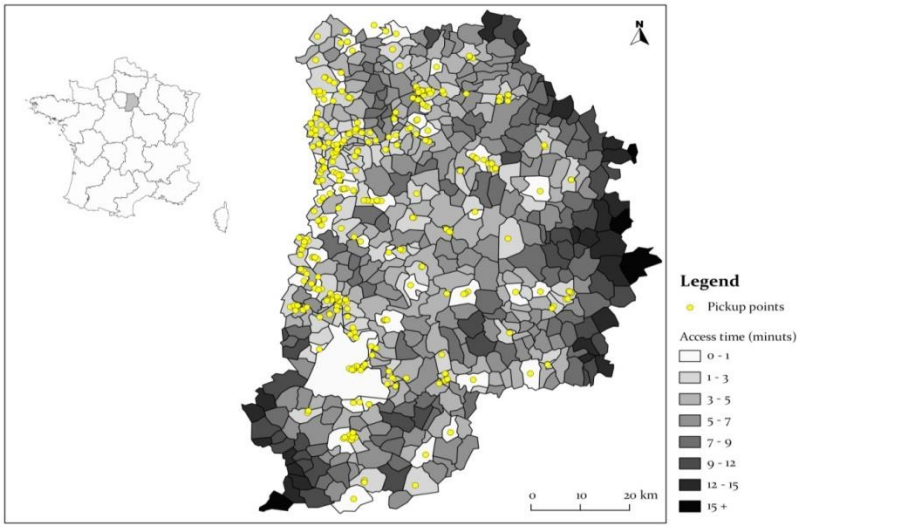
Access time

At the aggregate level, the four networks offer widespread coverage of Seine-et-Marne, securing very short access times by car in almost the whole Department. Our calculation shown on Figure 4 show that PP access time in most municipalities range from 1 to 7 minutes by car and 91% of the population is less than 10 minutes by car from the nearest PP.1 On

[1]One drawback is that PPs which are located just outside the mapped area (institutional borders of Seine-et-Marne) are neglected in the analysis.

average, each network provides an access time by car of between 4 minutes in urban areas and 8 minutes in exurban/rural areas.

FIGURE 4. Access time to PPs in Seine-et-Marne, 2012



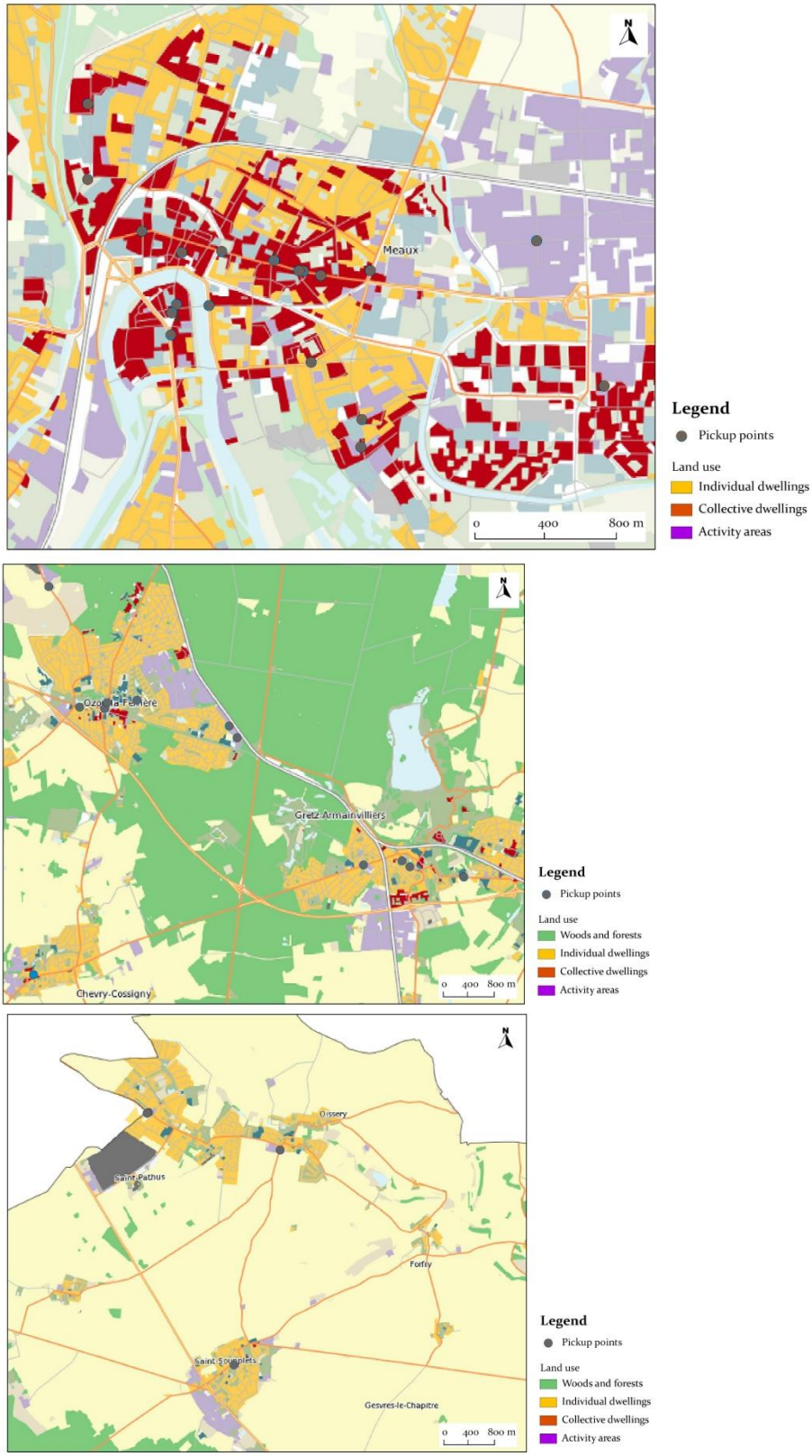
Map by F. Fortin, IFSTTAR

Location of the PP in the built-up and exurban/rural areas

Population density patterns around PPs were examined to ascertain whether and how different zones present different PP densities, thus three cases of respectively urban, suburban and rural zones were selected.. Some interesting patterns in the distribution of PPs across different areas can be noted in Fig. 5 (top), which shows the inner center of Meaux, an urban area with 50,000 inhabitants and 10,000 jobs. The Fig.6 (middle) also shows PP network location for two suburban municipalities, Ozoir (population 20,000) and Gretz (population 8,000) served by a regional railway (RER D). Then a rural area is represented in Fig. 7(bottom), reporting four small municipalities (on average 2,800 inhab. each) located in the North of the Department.

First, it emerges PP networks are implemented in cities as well as small villages of less than 3,000 inhabitants. Although dense urban areas remain better served, PPs are tending to become ubiquitous, with good accessibility even in rural areas, as proved by PP time and distances accessibilities.

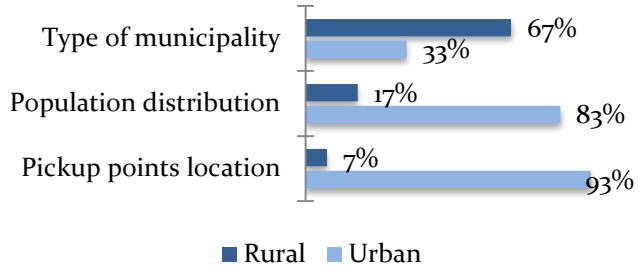
FIGURES 5,6,7. Pickup point location in urban (top), suburban (middle) and rural areas (bottom)



Maps by F. Fortin, IFSTTAR

In Meaux, an urban area, we observe a concentration of PPs in the main commercial street, which accommodate large flows of passers-by. In suburban and rural areas, PPs siting reflects the structure of villages or hamlets, where amenities are usually concentrated in the "urban core". Thus it can be observed that in small settlements, PPs are more often located in the most "urban" areas than on the road intersections at the entrance of the settlements. Whenever present, regional and local train stations are preferred targets for siting PPs.
Finally, as expected, PP density is high in the urban area and tends to be lower in low density residential areas and rural regions, where there are fewer services and amenities. However the PPs coverage presents a more than proportional decrease than the population decrease. As shown in Fig. 8, PPs are over-represented in urban areas (93%) in comparison with their share of the population (83%). This results in a reduced accessibility to PPs delivery option for rural population, and may contribute to explaining a marked higher preference for home deliveries in rural areas.

FIGURE 8. Disparities between urban and rural areas



CONCLUSIONS

In this paper, focusing on the strategy implemented by PP network operators, we have provided a description of pickup point networks and discussed the rapid growth of end-consumer deliveries in metropolitan areas and their adjacent near-rural environments. We have defined a conceptual framework that identifies the main variables and constraints that may affect the design of a PP network, and confirmed the hypotheses that underlie this framework with the results from a survey conducted among the main stakeholders (PP operators and shop-owners). The paper then presents the spatial relationships of PPs located throughout the Department of Seine-et-Marne. We have investigated the main locational patterns of PP networks, comparing urban, suburban and rural settings and examined the correlation with population density, activities and transport systems. We have measured accessibility in terms of time and distance.
Our results are threefold. First, we have documented the recent development of alternative parcel delivery services to e-shoppers in Europe, and especially in France, which has the highest rate of PP use among the main European countries. Secondly, we have described how the operators have decided to organize their PP network and assessed the relevance of the population density and the vicinity to public transportation nodes while designing the network.

Finally, and quite importantly, our research shows that at the French national level, PPs are now a well-established alternative to home deliveries and their presence covers urban, suburban and rural areas. While PP density in remote areas decreases faster than population density, rural e-consumers' accessibility to PP sites has reached a viable level. This raises important questions about the overall mobility (commercial+private) related to e-commerce in urban regions.

Potential research topics and policy recommendations

We suggest that PP parcel flows should be included when the next version of the urban freight FRETURB model is designed. This new version will benefit from recent quantitative survey results on urban freight patterns in the Paris region (Routhier, 2013) which do not include any specific focus on PP networks. Similarly, efforts to identify the net impacts of e-commerce deliveries on overall mobility from delivery operators' commercial trips and end-consumers' pickup trips could benefit from a detailed understanding of PP network configuration. The potential gains, in terms of reduced vehicle-kilometers, on the commercial side of truck and van movements may well be lost due to increased private car trips, especially as suburban and rural residents gain access to PP services.

Moreover, we consider that it would be interesting to investigate how home deliveries vary according to the type of housing. Households living in high rise buildings may have a very different pattern for home deliveries (increased use of PPs) from households in single-family homes, as some of our respondents and certain aspects of our spatial analyses have suggested.

This type of research could provide interesting information for urban planners and residential developers when considering new developments by helping to quantify the demand for home delivery services these developments may generate.

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