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The impact of new practices for supplying households in urban goods movements: method and first results. An application for Lyon, France.

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Abstract

Purpose: This paper describes an original methodology to understand the new purchasing practices of households (e-commerce, home deliveries, etc.) and its first results.

Methods: the data available for measuring the magnitude of the changes due to new purchasing practices remain partial and poorly adapted for mobility analysis. We therefore explore the data available on e-commerce and related practices, in order to discuss their pertinence and eventually propose an original methodology.

Results: a pilot survey was performed at the end of 2015 to test the methodology in order to perform a full scale survey planned for the end of 2016. This paper presents the general results of this pilot survey.

Conclusions: placing this survey in perspective with mobility surveys performed in France should reveal elements of explanation for the changes occurring in urban logistics in Lyon and more generally in French cities and towns. Thanks to this methodology of survey and its first results, we can infer on the importance of new purchasing practices in urban freight movements and households mobility.

Keywords: Survey methodology, urban goods movements, end consumer trips, e-commerce

1. Introduction

E-commerce has often been considered as one of the main driving forces of the change in urban logistics. Despite of the interest it spurs, the data available for measuring the magnitude of this change remain partial and poorly adapted for analysing its impacts on goods flows.

It is obvious that e-commerce practices are quickly evolving. For instance e-commerce goods and services sales increased from \$1,014 bn in 2011 to \$2,251 bn in 2015 [1]. This volume of online purchases represents 4 to 6% of B2C transactions (in turnover) for goods exclusively. In Europe 4 billion parcels were sent in 2015 [2], demonstrating the consistency of the impact of B2C e-commerce on freight transport. Data show that in France e-commerce concerns 63% of people. However this number increases to 69% when phone and mail purchases are included and remains stable between 2008 and 2012 (70% in 2008 and 71% in 2010) [3].

In this new paradigm, recent reflexions highlighted the rapid change in consuming practices and their impact on freight transport, without necessarily tackling the subject of quantitative analyses. Visser et al. [4], develop a reflexion about the way e-commerce can influence freight transport through a theoretical framework, which can only be discussed through heavy field measurements, paving the way for future data collection methods. Nemoto et al. [5] also examine the impact of e-commerce and information technologies on urban freight through a series of hypotheses that could not be verified according to the authors due to a lack of statistical evidences. Assumptions include a growth of e-commerce, resulting in higher freight traffic, but also more opportunities for local authorities and carriers to optimize urban logistics systems.

Gonzalez-feliu et al. [6], discuss the new trends in urban freight simulation through e-commerce and already existing modelling frameworks, suggesting an original method, however concluding on the necessity of accurate and reliable data on home deliveries and pick-up points. Durand et al. [7] propose a modelling framework on the effects of proximity delivery services on shopping trips related to e-grocery, using heteroclite sets of data for its calibration, emphasizing the need for coherent datasets. Visser et al. [8], later focus on home deliveries and their impact on freight transport, through a literature review, concluding that only an holistic approach (therefore mixing freight and people mobility) would be efficient to understand the impacts of the new delivery practices, thus enlightening the need for original approaches.

A more operational work is carried out by Wygonik et al [9] on grocery deliveries in the US and the use of shared vehicles for reducing CO2 emissions. This work shows the interesting potential of transport consolidation of home deliveries compared to personal vehicle travels. Gevaers et al. [10] present a typology of last mile deliveries in the urban context, and a B2C paradigm, indicating the importance of the value of goods and proxy

variables (consumer service, security, geographical parameters, technology and environmental variables) in innovative and optimized transport practices. Describing a theoretical framework, the authors conclude with the need for quantifications and field measures.

In fact, whether the data are national statistics based on household expenditures or those of professional organisations (based on the number of transactions of the main web-merchants), no statistics allow to measure the goods movements that these new forms of purchase generate.

We observe here a need to quantify new shopping practices and feed the decision making process for both private operators and local authorities. It is therefore necessary to examine the flows generated by households in order to explain their practices through their social, spatial and economic profiles. In this logic, the Greater Lyon local authority (eastern France, pop. 1.4 million) asked at the end of 2014 for a specific survey tackling the question of the new shopping practices related to e-commerce. The final target was to build a decision support tool for urban planners to build policies related to urban goods movements and consumer behaviours. This survey would serve both as a diagnostic tool, and a basis to design a model in order to understand the impact of home deliveries, pick-up and related practices, on road occupancy and more generally mobility. The results of the survey would therefore feed the urban planning process with an insight on the new purchasing practices, and allow decision makers to formulate orientations in terms of policies related to consumer mobility (what sorts of practices are to be favored, and why?).

Given the state of knowledge concerning new practices, it was at the time obvious that local decision makers needed to broaden the range of tools used to understand mobility, with specific data collection methods. It appeared that the subject that had to be examined was the disconnection between the act of purchasing and the reception of the goods, both spatially and temporally and not only e-commerce. In this case this sort of practice was called “deferred purchase and reception” (DPR), which is the subject we will study in this paper, and will be detailed in part 2, along with the methodology to survey this phenomenon accurately.

Therefore, one of the first questions concerned the data sources available to understand the structure of DPR and its influence on people’s mobility, and their capacity to explain the stakes defined by urban planners. The objective was to determine whether or not a specific survey had to be done. This object will be discussed in part 3. The application of the methodology applied in Lyon and the first results will be explained in part 4 and 5.

2. A Methodology To Understand DPR

We consider in this work the practices that are excluded from the “classical” purchasing framework, which we consider here typically as the trips operated by the households in stores, resulting in a purchase of goods immediately picked-up by the consumer. In the “classical” paradigm it is possible to explain the mobility thanks to the already existing surveys related to urban goods movements and households’ trips. However in the new paradigm enlightened by the e-commerce, it is impossible to measure the mobility resulting from these new practices as shown in the next figure (Fig. 1).

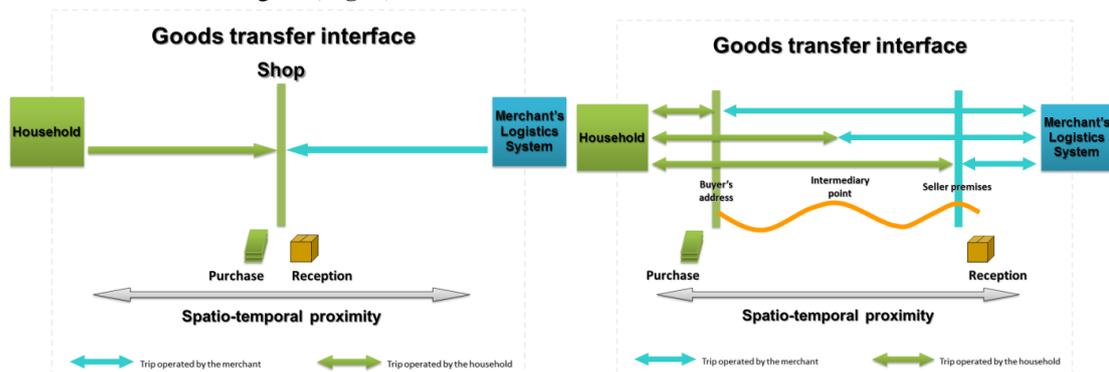


Fig. 1: A comparison between the classical purchasing framework (left) and the diversity of channels since the e-commerce (right)

As we can see the important number of practices call for a definition of the object we will now discuss, and why we do consider the term “e-commerce” to be unfit for several reasons.

Firstly the e-commerce includes a vast majority of virtual flows that do not have any impact on people or goods mobility. For example in Europe the most frequently purchased items are mainly related to leisure and tourism (trips, hotel stays, insurance, etc.) and do not result in physical goods trips [2]. Therefore, including this type of item would not be efficient in our analysis. Secondly, we know for a fact that e-commerce is not the only channel which generates home deliveries. It is common that some stores (for example grocery stores or household appliances stores – for example Carrefour or Darty in France) offer home delivery services depending

on type of goods that are purchased: in this situation there are no distant transactions but the home deliveries still occur. Though these kinds of purchases are excluded of the e-commerce sphere, they are indeed involved in the evolutions of purchasing and mobility behaviours. Lastly, the term “e-commerce” is often associated to internet or smartphone purchases, but even if the majority of transactions are operated through these channels, the telephone or mail purchases do endure, especially for some social profiles (elderly people or remotely located households).

Consequently the similarity between the physical movements linked to the e-commerce and shop purchased goods that are delivered at home, is the disconnection between the act of purchasing and the reception of the goods, both spatially and temporally, which is the element we call Deferred Purchase and Reception (DPR, Fig. 2).

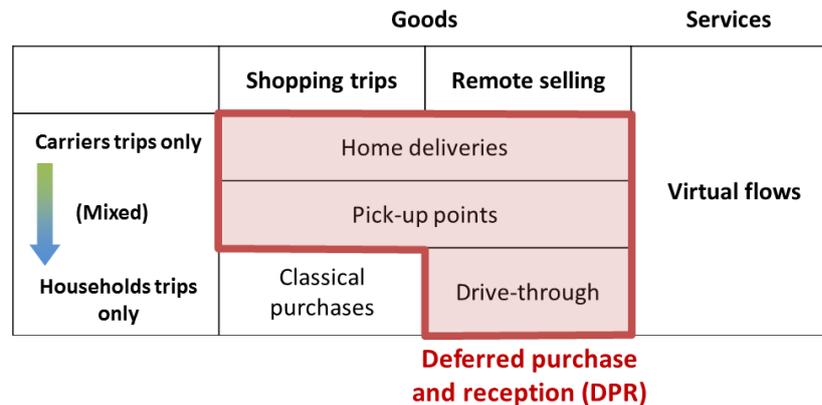


Fig. 2: DPR as our object of study is better fitted to understand the evolutions of mobility linked with purchase behaviour

We can formalize three practices that characterize the core of deferred purchase and reception:

- the case were the order is placed online (or on the phone or by mail), and is then home delivered,
- the case were the order is placed online (or on the phone or by mail), and is then delivered in a pick-up/relay point
- the case were the goods are purchased in a shop, but are not immediately picked-up by the consumer and is then delivered at home (or another address given by the buyer).

The main questions we try here to answer with a dedicated methodology are:

- Who is concerned by deferred purchase and reception practices?
- How these purchases (and the subsequent receptions) are operated?
- What are the characteristics of these behaviours considering the profiles of the households (geography, composition, etc.)?

In order to fully understand how DPR movements affect the public space we need to understand:

- The frequency at which the goods are picked-up or delivered for the household
- The transport mode used to pick-up or deliver the goods (specifying if the trip was made by a transport operator or individuals themselves)
- The origin and destination of the trip
- The type of goods purchased
- The channel of purchase (internet, phone, shop, etc.)

All these information have to be crossed with accurate data on the household itself (location, number of people it is constituted of and their characteristics, ownership of vehicles, wages, etc.) in order to determine behavioural profiles. Moreover, these data are similar to data produced by urban goods movements surveys and households mobility surveys, giving the opportunity to link these survey together in order to complete a vision of both people and freight mobility in the urban environment. It is then possible to better understand the interactions between mobility and territories through new shopping practices.

The best observation method to observe DPR is to focus on the households as it allows:

- The observation of the convergence of goods flows
- Representativeness of households, and therefore trips generation profiles
- The observation of the diversity of practices

By concentrating the observation on the households rather than on other actors of the commerce, it is possible to study the diversity of households' profiles and subsequent supplying practices (Fig. 3).

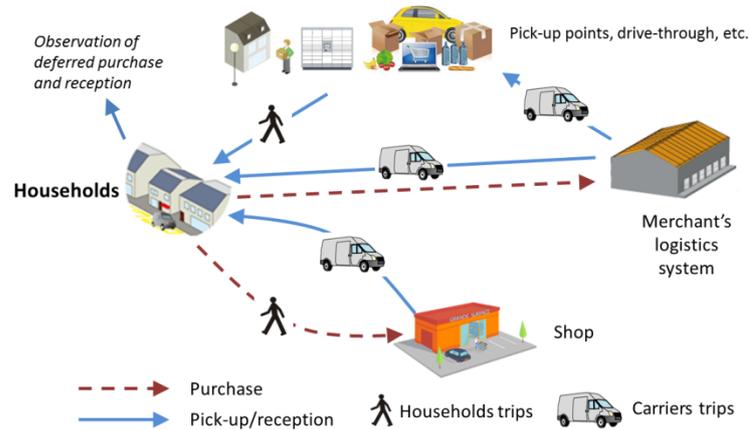


Fig. 3: Deferred purchase and reception framework indicating the household as the point of convergence of goods, therefore the most adequate sampling unit for a survey

This approach also means a higher technical efficiency as it is not necessary to adapt the data collection methods depending on the type of stakeholder: one method is used, thus one questionnaire, which simplifies the work of both the pollsters and surveyed people. We will now explore the resources related to DPR mainly in France, with a glance on international data sources.

3. A Review of the Available Data Sources

In order to be efficient a data source has to correspond to three characteristics related to our object of observation: pertinence, measurability and coherence [11]. The pertinence is the correspondence between the target of the survey (in terms of diagnostic and modelling purpose) and the way of measuring the observed phenomenon through a simplified vision of the reality that is a survey. The measurability is essentially linked to the unit of observation chosen and its capacity to synthesize the studied phenomenon. Lastly the measure has to be coherent with the final target of the study: in this case modelling the road occupancy related to new consuming practices. But it also has to be coherent with other mobility approaches on freight and passengers.

3.2. Merchant's Data Sources

Web merchant and home shopping companies association produce regular reports and data on the evolution of the distance selling market. These data mainly relate to the buying behaviours of the consumers, but not to their mobility practices. The main information given by the data produced by these means are turnover volumes, ordering channels, consumer confidence indexes, etc. [12]. Very few information exist on the way goods have been transported, and how the clients received them and the volumes implicated. In France, the web merchants and home shopping companies are represented by an organisation called FEVAD (e-commerce and home shopping companies' federation). This association has recently produced an observatory, consolidating most of the data on home deliveries and operated by the web merchants and their transport operators [13]. If the data produced by this observatory represent an important volume of deliveries¹, it is today near impossible for technical and ethical reasons to link these deliveries to their recipients and their characteristics in order to produce behavioural data. Moreover, the data produced are only related to distance selling, but as discussed earlier, e-commerce and home shopping are not the only channels that generate deferred purchase and reception.

Other data exist that are related to shopping behaviours: regular surveys are carried out by the chambers of commerce and industry in most of the cities in France. In Lyon for example these surveys are carried out every five years and allow the chamber of commerce to monitor shopping trends. These surveys are however designed to answer questions concerning customers' catchment areas and trade volumes, but not about goods or households movements, meaning there are unfortunately no data concerning deferred purchasing and reception. The main drawback of this the survey resides in the description the last event only for each household interviewed, which is a debatable approach when describing general behaviours.

¹ 40 million parcels delivered every year censored on the whole country.

3.3. Mobility Data Sources

3.3.1. Freight surveys

Are urban freight surveys fitted to understand the phenomenon linked to home deliveries, pick-up points, and more generally goods trip generated by households?

Patier et al. [14], after a review of the existing surveys around the world, present a methodology to understand globally and accurately the structure of freight movements in cities. This urban goods movements survey (UGMS) method was designed in the mid-1990s in order to understand the generation factors and structure of urban freight transport. To characterize all the logistics operations linked to movements, the UGMS is organized in three nested sections for the following target populations: the establishments, the drivers serving these establishment and the carriers operating in the study area.

The establishment survey is carried out on economic establishments located in the city. In this survey, no movements are related to households, except home deliveries expeditions in some cases, but this approach does not explain trip generation by households. It is also possible to know if the establishment serves as a pick-up point but only describes the reception of goods, not the movements operated by the households.

The driver survey provides information on the mode of operation used by the people managing goods transport (type of vehicle, number of stops on the circuit, activities served, itinerary) etc. Some deliveries described in this survey are home deliveries, however it is not possible to know the characteristics of the households, linking the trip generation with household profiles. Furthermore, the number of events is too low to pretend building a set of data concerning DPR.

Shipper surveys offer another potential in home deliveries data sources. These surveys follow a shipment from its original sender to its final consignee, it would be therefore probable to observe home deliveries [15]. We could not find any evidence of such data existing, and as discussed in other methodological works, the contribution of shipper surveys in urban goods movements is difficult to determine and statistically debatable, offering no clear vision of freight movements inside a city [16], but is rather useful to understand the articulation between the city and global logistics systems in a larger scale.

These two last elements can produce some home deliveries information, but the quantity and accuracy of data is not sufficient to explain the formation of goods flows by households. These surveys are indeed able to describe very precisely the freight movements between establishments, but do not take enough into account the movements generated by the households to study DPR. Other surveys in other parts of the world, though using different methodologies also lack similar data as they also focus on establishments or carriers activities [17], [18].

3.3.2. Household mobility and end consumer trips

End consumer shopping trips are already a relatively well tackled subject today, resulting in various models all deriving from surveys [19], [20], however these data sets and the subsequent models do not include home deliveries or pick-up trips. These data being in fact essentially derived from household mobility surveys and hardly identifying e-commerce related trips.

Household mobility surveys are designed to understand people mobility and offering a decision support for local authorities. Carried out in France since the 1970s, the method is standardized in order to be applicable for any territory, allowing nationwide comparisons. The data collected in these surveys describe: the household (location, composition, ownership of vehicles), the characteristics of the members of the household, the trips of each person of the household, the decomposition of each trip into routes.

Each trip is characterized by a motive, including shopping trips, which is the closest to our interest in this paper. However this type of survey is unfit to collect data on either home deliveries or relay points pick-ups, as the first does not concern people mobility, and the second is included inside shopping trips but with no means to differentiate simple pick-ups to a real shopping trip.

We summarize in the next tables the possibilities offered by each type of surveys concerning DPR (**Table 1**).

Table 1: Characterization of mobility variable available through existing data sources

DPR	Household surveys	UGM/Shipper surveys	Consumer behaviour surveys
Home deliveries (remote)	No	Statistically weak	Yes
Store-picking/pick-up	Not identifiable	No	Yes
Home deliveries (shops)	No	Statistically weak	No

As we can see, household surveys are unfit to describe DPR. Freight surveys and consumer behavior seem to be more suited for this approach. However freight surveys will only focus on home deliveries, with a low representativeness. Consumer behaviour surveys produced by merchant and the chambers of commerce are

finally the closest to describing DPR. However webmerchants surveys do not focus on the mobility of household: it is not possible to describe how household will pick-up their goods, except for home deliveries. Chamber of commerce surveys give some data about mobility but do not at all take into account the DPR phenomenon, as their purpose is to focus on the local economy and commerce (**Table 2**).

Table 2: Characterization of mobility variable concerning DPR through existing data sources

DPR	Household surveys	UGM/Shipper surveys	Consumer behaviour surveys
Frequency	No	No	Yes
Transport mode	No	For home deliveries only	No
Trips descriptions	No	For home deliveries only	No
Type of goods	No	Yes	Yes
Channel of purchase	No	No	Yes
Households characteristics	Yes	No	Yes

None of the data sources described previously corresponds to the exigence of coherence, measurability and pertinence concerning deferred purchase and reception. Moreover, the linkage between these surveys is difficult as they do not have the same units of observations (movement for UGM, shipment for shipper surveys, trips for household, act of purchase for consumer surveys), and even their combination would not be enough to observe the DPR phenomenon accurately and in its entirety. It is therefore more efficient to build an original method to understand the new supply practices of households.

4. An Application of the Survey Method in Lyon

Despite the optimized approach here presented, the survey had to be divided into two phases for technical and financial reasons. Indeed, even if it is possible to approximately know the proportion of the French population that uses home shopping services and e-commerce²[3], we do not know the proportion of households concerned by deferred purchase and reception practices as it also includes purchasing trips resulting in home deliveries. This unknown factor increases the difficulty to scale the survey, which is why it was necessary to build a pilot phase to quantify who is and who is not concerned by DPR movements.

This pilot phase took place at the end of November 2015 in the conurbation of Lyon (approximately 1.4 million inhabitants), with a CATI³ data collection. The sample was constituted of 1000 households respecting geographical, age, gender and socio-professional quotas. In order to adapt the survey to a form more fitted to phone data collection, some questions were simplified (concerning the mode of transport), others were omitted (origins and destination, channel of purchase), only focusing on whether the household is concerned by DPR, and what is the intensity of these practices (frequencies of purchases).

The questionnaire was divided in two parts, including twenty to forty questions depending on the practices of the household, to not exceed a duration of 15 minutes which is considered an acceptable duration for CATI. The first part included general information on the household: address, number of people constituting the household (with a precision on children), age, gender and occupation of the head of the household. The second part focuses on whether the household interrogated generates DPR or not. If it does, questions focus on which sorts of goods the household bought, how many times during the past twelve month, and how did they receive it. The types of goods were divided in nine aggregated categories to simplify: healthcare and cosmetics, cultural and high tech products, clothing, household appliance, furniture, groceries, catering, gardening and do it yourself products, and others. Purchasing and reception behaviour were described for each type of goods mentioned.

The results of this pilot survey therefore include:

- the proportion of households concerned by DPR,
- the determination of DPR intensity regarding household profiles.
- the number of DPR trips generated by households for the Lyon conurbation.

These elements will be necessary to increase the efficiency of the second phase of the survey which will be carried out during 2016. In this step, the data collection will be heavier as we will ask for each household surveyed the description of every trip due to deferred purchase and reception during an extended period of time (several weeks).

² 69% in 2012 according to study by Crédoc (French center of research for the observation and study of living conditions)

³ Computer Aided Telephone Interview

In this second phase, the final sample will be doubled (expected sample 2000) and will include both parts of the pilot survey and extensive data capture in a log book during several weeks for each surveyed household, also including some of the household interviewed during the first phase for efficiency reasons. This approach will mix both CAWI⁴ and CATI. The CATI approach is used both for interviewee recruitment and to capture the less generative profiles. The CAWI system is relevant when it comes to intensive buyers using the internet extensively.

This second phase will provide more precision about the goods movements generated by households, but also the routes and trips that result from DPR practices. We will then be able to make the junction between household and freight mobility in the urban environment, completing the approach of mobility for decision makers and urban planners.

5. First results

We will now examine the general results of the pilot survey to characterize its structure and also to understand its role in urban freight distribution and generation. The main questions this pilot survey addressed were : who does and who does not practice DPR ? And how many DPR households generate for a certain period of time? After weighting the results of the survey in the general population we were able to determine that in average household generates approximately 19.2 DPR per year in the greater Lyon perimeter. These purchases are distributed in various synthetic types of goods as follows (**Table 3**).

Table 3: Number of annual DPR for each type of goods

Type of goods	DPR frequencies (annual)	DPR frequencies (%)
Groceries and catering	7.2	38%
Clothing	3.8	20%
High tech and culture	3.1	16%
Household appliances, furnitures, others	2.6	14%
Healthcare and cosmetics	2.5	13%

Food products account for most of the DPR in a household (38%). This category is extremely varied in terms of practices. The recent growth of home delivery services in the restauration sector, but also drive through establishments in France explain this predominance. Their impact on road congestion is also variable because the reception can be operated by motorcycles (for restaurants) or bigger vehicles (for groceries) or even by households cars (because of drive through practices). High tech, cultural products, clothing, healthcare and cosmetics are usually not delivered at home but are usually picked-up by the household in a different location. Their influence on road occupancy is then mostly explained by household mobility. Household appliances, furnitures and other heavy products represent 14% of the annual DPR for households, but their impact on urban freight is higher than other types of goods because they are usually operated with bigger vehicles and mostly delivered at home.

Through the analysis of the various socio-professional profiles, we can observe a strong relationship with their tendency to generate DPR. 73% of the households generate DPR, but this penetration ratio varies from 57% for retired people, to 92% for higher professional and managerial occupations (**Fig. 4**).

⁴ Computer Aided Web Interview

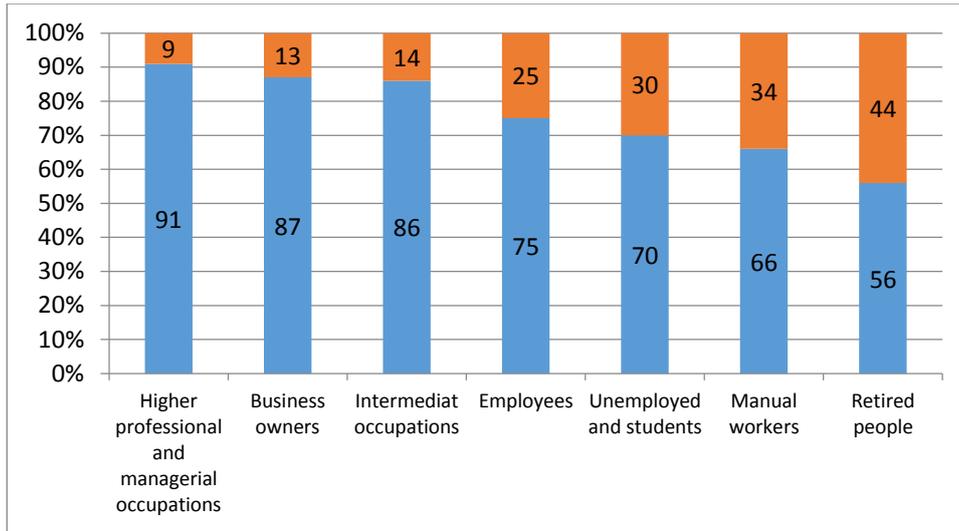


Fig. 4: Proportion of households practicing DPR according to their social profile (head of the family)

There is obviously a strong relationship between social profile and DPR practices. As for the penetration of DPR practices for different types of households, the intensity of practices also depends on the social profiles (Fig. 5).

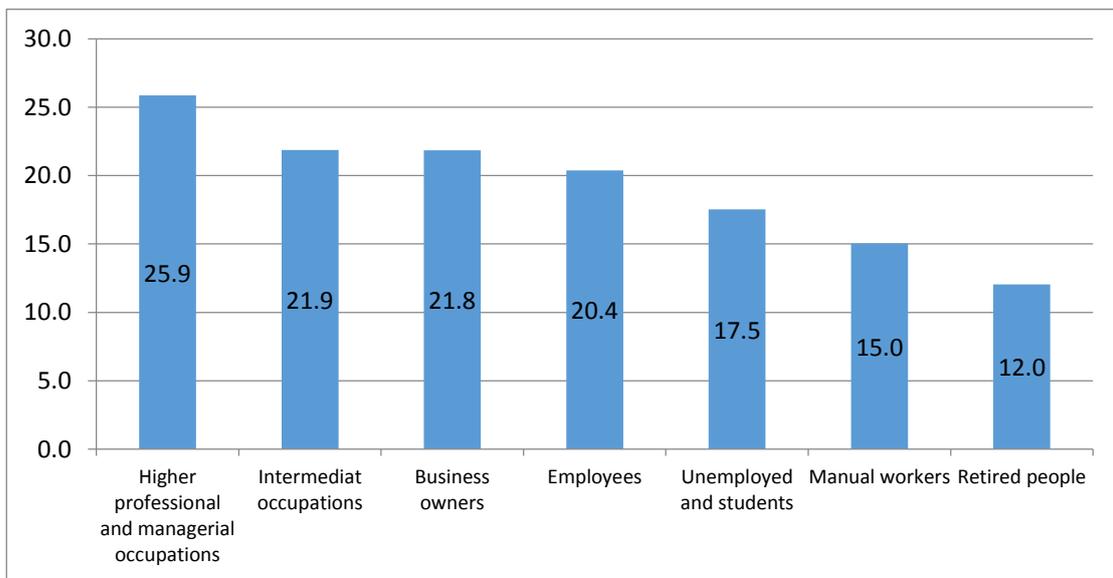


Fig. 5: Number of average annual DPR dependin on the social profile of the head of the household

Similarly to the penetration ratios, the number of DPR depends on the social profiles in the exact same way. However, considering the various forms that DPR can take (home deliveries purchased remotely, pick-ups in specific places other than the house or home deliveries due to a regular purchase in a shop), the social profile explains the practices differently (Fig. 6). The proportion of home deliveries is for example high for both the wealthiest households (such as business owners) but also the poorest (unemployed people). In this case we can formulate the hypothesis that the presence of people in the house and time availability explain this variations. These practices must consequently be examined through other variables or proxys to explain the nature of DPR behaviours, which are still to be studied.

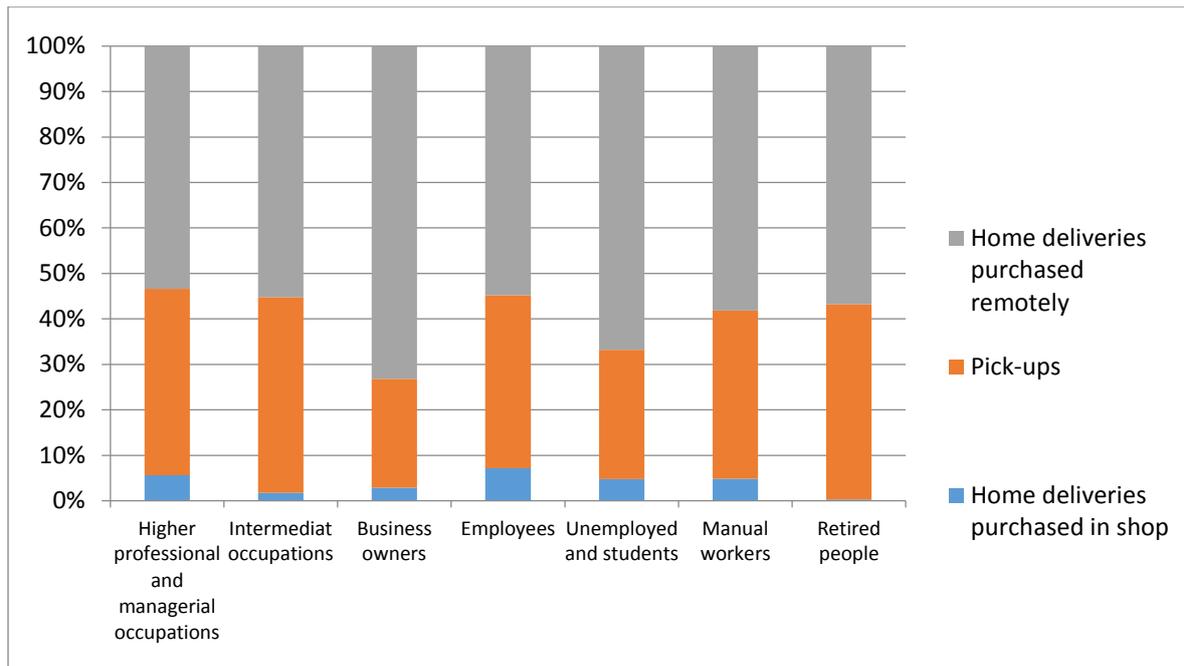


Fig. 6: Proportion of DPR practices (in three aggregated types) according to the social profile of the head of the households

Therefore, the social profile of the household seems to be of importance in the determination of DPR practices. However we can argue that other variables can impact DPR practices: housing, workplace localization or other cultural variables. For the time being there is no evidence of an influence of the spatial profile on DPR intensity and forms of practices. The analysis of location of the households themselves which was studied for this survey did not prove to be explanatory. In fact the characteristics of the housing itself and its location have to be coupled with other data such as general mobility behaviours and can be approached through the study of other activities and the means of transport of the households. These elements will be addressed in the next phase of the survey.

We will now put DPR in the larger picture of urban goods movements (UGM). We can define UGM as all the movements of goods operated between the establishments of a city, but also shopping trips generated by households, public works and waste management[21]. These movements are structured as follows in vehicle kilometers private car unit equivalent (PCU) [22]:

- Inter-establishment movements that account for 40% of vehicle kilometers in urban areas
- End consumer movements traditionally characterized by shopping trips by households which represent 50% of the vehicle kilometers.
- Urban management movements that include public works, postal services, waste management and represent a share of 10% of vehicle kilometers of UGM

For the example of the Greater Lyon perimeter, inter establishment movements represent 620,000 weekly movements⁵. The number of DPR is 215,000 movements per week with the following distribution⁶:

- 55% are due to home deliveries purchased remotely
- 35% are related to store-picking or pick-up points
- 5% are home deliveries purchased in shops

In total, home deliveries represent approximately 130,000 weekly movements, representing little more than 17% of inter-establishments goods movements in the city. When compared to shopping trips⁷, DPR movements represent 7% of trips due to households purchases.

These results show that DPR still represents today a small part of traditional end-consumer trips, with a limited impact on peoples' mobility. However the impact of these practices is much higher for the supply-chain stakeholders, making it an important subject for urban freight policies. We also observe that e-commerce and

⁵ Freturb modelling [23]

⁶ Weighted results of the DPR survey

⁷ Household mobility survey, Lyon, 2015

remote selling explains 95% of DPR, making e-commerce focused analyses globally relevant when it comes to new shopping practices.

6. Conclusion

This work only applies yet for the conurbation of Lyon, but the target of this work is also to lay the basics of a data collection methodology to explain the new supply practices of the households, and the way they impact urban mobility of both freight and people. Further work will include the application of the second phase of the survey and its analysis. This second phase will allow a refined study of the mobility behaviours related to DPR, trying to explain the choices in terms of mobility and purchasing practices.

The strength of this survey lies in the capacity to describe and explain the mobility related to DPR for both freight and passenger. It is therefore possible to compare the data captured in this survey to others (as shown in part 5). The main opportunity would be to integrate this method into other mobility surveys. As this survey shares many similarities with households' trips surveys, it is thinkable to integrate parts of the presented methodology into the already existing peoples' mobility surveys, with a minimal impact on the quality of data on both households trips and DPR. However the main weakness of this survey lies in its own specificity as an independent survey that is not a traditional, and only focuses on one territory, which also constitutes a threat in terms of comparability between territories in a modeling approach.

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