Analysis of different types of freight tours according to their logistics organization in the Paris Region

Abstract

Policy makers require urban freight data to get an understanding of freight operations and to anticipate the effects of policy measures. However, most of the urban freight data does not distinguish the type of supply chain involved and goods carried, and detailed and quantitative knowledge on the supply of urban freight transport is lacking in the literature. This paper aims to investigate how the logistics organizations of transport operators affect the shapes of urban freight tours. We use data from the Paris Region Urban Freight Survey for delivery-drivers. Qualitative interviews and literature are used to build a typology of freight tours, according to the logistics organizations of the transport operators. After showing some descriptive statistics and visual representations of the different types of tours, we try to model the freight tours using other variables. The policy and theoretical implications of our work are finally discussed.

Key-words: City logistics; freight tours; logistics organization; Paris region

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1. Introduction

Urban goods movement (UGM) was defined by McDermott (1980) as comprising all freight distribution within an area of a city with a population of more than 50,000. This includes not only the movement of goods into cities; it also relates to pick-ups, reverse logistics, home deliveries, or transport equipment for the construction industry (Russo & Comi, 2011). Each activity (commercial, service, industrial, administrative etc.) taking place in an urban environment has specific transport needs and can be associated to a specific profile of freight generation (Dablanc, 2007). That’s why urban freight data is required to provide an understanding freight operation and to monitor the effects of policy measures (Browne et al, 2007; Patier & Routhier, 2009).

Most of the logistics-related policy measures are made on the basis of the experience and intuition of experts, skilled operators and planners, partly because of the lack of data about UGM (Taniguchi et al, 2006). Much of the available urban freight data doesn’t distinguish the type of supply chain involved and goods carried. Sectorial data about freight activity is one of the main gaps in urban freight data (Allen et al, 2014). According to a literature review by Figliozzi et al (2007), there have been very few efforts to collect disaggregated data on freight tours. Three studies are mentioned in particular, in Canada (Stefan et al, 2005), the USA (Holguin-Veras & Patil, 2005) and the Netherlands (Vleugel and Janic, 2004). Figliozzi (2007) also mentions that freight tours are generally ignored in traditional four-step transportation modeling approaches. This observation is only partly true: in France, researchers from the Laboratory of Transport Economics have been studying freight tours’ disaggregated data since the 90’s, and using it to model occupation of the road network in Freturb (Toilier & Routhier, 2007). However, we agree with the fore-mentioned authors on the fact that detailed and quantitative knowledge on the supply of urban freight transport is lacking in the literature.

The aim of our paper is to partly fill the gap on this subject, using data from the Paris region Urban Freight Survey. Our study proceeds as follow: in section 2, we propose a short review of literature on the collection of quantitative data for urban freight tours, and we describe the database that we used in this paper for our analysis. In section 3, we use qualitative data and literature in order to profile our freight tours and build a typology according to the logistics organization of the transport operators. We also show some descriptive statistics and visual representations of these different types of tours. In section 4, we try to model the freight tours using other variables, using a simple multiple regression model. Finally, section 5 offers some perspective on the theoretical and policy implications of our findings.

2. Data description

Collecting quantitative data for city logistics tours: a short state of the art

It is impossible to make definitive statements on the needs for data in urban logistics (Ogden, 1992). Those needs vary according to the studied problem, the political and strategic framework from which the problem emerged, the economic and technological limitations of data collection, and the availability of data. Three methods, which can be relied on to gather disaggregated tour data, are mentioned in Pluvinet et al, 2012.
Driver surveys make it possible to collect data on the general structure of the vehicle tour, and on the operation where the survey is taken: variables can include the point of origin, the parking location, the handling tools, etc (Allen & Browne, 2008). However, this data collection method doesn’t provide detailed information on the trips within the tour, or on the characteristics of operations to other establishments.

Vehicle trips diaries make it possible to collect data on the activity of a single vehicle: served establishments, operations, nature of goods, hours of departure and arrival, etc (Allen & Browne, 2008). However, these surveys are generally self-administered by the drivers (or sometimes by other employees of the freight operator), they can have low return rates and collected data may be very difficult to work with (McCabe et al, 2006).

GPS surveys make it possible to collect detailed spatial data on the trips of surveyed vehicles within a tour: localization, knowledge of distance and duration, number and location of stops… However, when they are not associated with alternative survey methods (Roorda et al, 2009), GPS surveys can’t inform us on the nature of transported goods, or on the nature of performed operations during stops (Sinarimbo et al, 2004; Greaves and Figliozi, 2008; Joubert and Axhausen, 2009; Joubert, 2010; Pluvinet et al, 2012).

Another type of survey, which is not mentioned often in the literature, is the embarked survey. This was used with very efficient results in the French UGM of the 90’s in Dijon and Marseille. They require an investigator to be inside the vehicles during the tour. Of course, the cost of this type of survey is higher than other methods, which is why it is not used often.

*Description of the French Urban Freight Survey methodology in the Paris Region, and weighting process of the observations*

The French Urban Goods Movements Surveys (UGMS) and its application to the Freturb software have been largely documented in the past (Ambrosini et al, 2010; Routhier & Toilier, 2007). The UGMS is actually made up of two main surveys: one of the economic establishments, and one of the drivers. The outline for the methodology is as follows: first, a sample of establishments, representative of the economic activities of an urban area is extracted from a comprehensive establishment database. When phone contact is made with a sampled establishment, a first interview is conducted by an investigator. This interview is used to characterize the establishment by variables that could be relevant to describe the generation of freight movements. During this visit, a log book is handed to the surveyed establishment. During a week, the establishment fills out the log book, and gives detailed information on deliveries. The final phase is a second visit of the establishment, to gather additional information on the deliveries. The second survey deals with delivery-drivers. It is distributed during the survey week by the establishments to drivers when they deliver goods during the surveyed week. The drivers have to send the survey back by postal mail. Also, for some delivery-drivers, GPS tracking is used, with an investigator embarked in the vehicle.

The survey of economic establishments is used to calculate freight trip generation ratios for establishments of a given activity type and size (again, see Ambrosini et al., 2010, for more details). Those freight trip generation ratios can then be applied to calculate the number of freight trips for an entire urban area. The driver survey is used to calculate an average distance between points according
to several factors (type of vehicle, type of activity, management mode, number of stops, or density of space…). Those “distance functions” are then used in the Freturb software to compute road network occupation (Routhier & Toilier, 2007).

The methodology for these surveys was developed by the Laboratory of Transport Economics in the 90’s for application in Bordeaux, Dijon and Marseille, three medium-sized French cities. In 2010, the Paris Region (Ile-de-France) was surveyed. The data used in this paper originates from the survey. For various reasons, ranging from the difficulty to investigate a mega-city such as Paris (larger travelling distances for investigators (Toilier et al, 2015)), to the reluctance of surveyed professionals to give detailed answers (which was worse in Paris than in smaller cities), the survey office in charge of the UGMS chose to deviate from the original methodology. As a result, the quality and reliability of the data was not as good as initially hoped.

A total of 928 tours were surveyed in the end. We were able to profile and describe with basic statistics a total of 546 tours (see section 3). The tours were weighted, using a methodology developed by the Laboratory of Transport Economics (Ambrosini et al, 2010). Finally, 333 tours (only from embarked tours) had enough data to be used for our multiple regression models (see section 4).

### Table 1 - Number of surveys collected according to the survey methods

<table>
<thead>
<tr>
<th></th>
<th>Auto-administered</th>
<th>Establishment-based</th>
<th>&quot;On the fly&quot;</th>
<th>Embarked</th>
<th>End of tours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nb of surveys</td>
<td>196</td>
<td>183</td>
<td>344</td>
<td>205</td>
<td></td>
</tr>
<tr>
<td>Data availability:</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Nature of transport operator</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of points</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Total distance</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Exact distance between points</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Total duration</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Duration of operations</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Type of operations</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Size of vehicle</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Management mode</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Type of establishments</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Nature of goods</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Packaging of goods</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

A total of 333 tours (only from embarked tours) had enough data to be used for our multiple regression models (see section 4).

### 3. Tours profiles and supply-chain organizations

*Identifying supply-chain organizations using qualitative interviews and data from the French UGMS*

To identify the tours profiles, five in-depth interviews were made with delegates of the mains French transport and logistics federations: FNTR (National Federation of Road Transportation), TLF (Transport and Logistics of France), UNOSTRA (National Union of the French Road Transport Union Organizations), SNTL (National Light-Transport Syndicate), UNTF (National Refrigerated-Transport Union). Three additional interviews were made with senior executives of some of the main companies.
of the bulking sector, to identify the internal segmentation of this highly concentrated sector, which has a strong presence in urban areas. We distinguished different tour profiles from the different interviews with these experts of sectors and markets of logistics carriers. Then, we used the data at our disposal to put each freight tour in a specific category.

To determine the profile of each tour, six criteria were selected: the nature of the operator, the specificities of the vehicle, the degree of homogeneity of the goods being transported, the type of service provided, the type of transport operation in bulking networks, the type of packaging of the goods being transported. Each criterion was applied one after the other on each tour. Thirteen tour profiles were characterized.

The “nature of the operator” criterion allows us to identify if the tour is made by the receiver of the goods being transported with his own vehicle (receiver’s own account) or by the sender of the goods being transported or a third party on behalf of the sender.

1. When buying a product, one can either be delivered by the seller (sender’s own account) or a transport service provider on behalf of the sender (third party transport) or use one’s own vehicle to collect the product at the seller’s premises (receiver’s own account). This is especially the case of many small independent retailers or community artisans. We used the management mode entered in the database to identify own-account as receivers. Out of 900 tours, we assigned 32 tours with this profile.

The “vehicle specificities” criterion allows us to identify whether or not the transport operation requires the use of a specific vehicle, dedicated to the kind of goods being transported. Thanks to the data about the nature of goods being transported, three tours profiles were identified: concrete transportation, automobile transportation and fresh-food products transportation.

2. Concrete transportation requires the use of a concrete mixer truck. These operations are carried out by concrete manufacturer with their own vehicles or with long-term rented vehicles with drivers, from their concrete plants to the building sites. The tours were assigned with the “concrete” tour profile if all the goods they transport are “concrete”, for the embarked surveys. For the other types of surveys, we used the Naf code of the transport operator (very precise categories of activity types). 17 tours were assigned with this profile among the remaining 868 tours.

3. Automobile transportation requires the use of a car carrier truck. The automobile transportation occurs from automobile assembly plants to the storage plants of the carriers, from these storage plants to the manufacturers’ dealerships, and sometimes between two different storage plants of the carriers. The tours were assigned with the “automobile” tour profile if all the goods they transport are “automobiles”. 8 tours were assigned with this profile among the 851 remaining tours.

4. Fresh-food products transportation requires the use of a refrigerated vehicle. Fresh-food transportation mainly serves three industrial sectors: the retail industry, the catering industry and the food industry (which has little presence in urban areas, in contrast with the foregoing). The fresh-food products transportation in the food and the retail industry is often outsourced by food industrialist and major retailers to specialized logistic service providers (notably STEF, a European leader for refrigerated logistics services), who often subcontracts transport
operations to smaller companies specialized in refrigerated transportation. The catering
distribution is made by the catering companies with their own vehicle, or are subcontracted to
small companies specialized in refrigerated transportation. For embarked surveys, the tours
were assigned with the “fresh food” profile if more than a half of the goods they transport are
“fresh food products”. For the other types of surveys, we used the Naf code of the transport
operator. 72 tours were assigned with this profile among the 843 remaining tours.

The “homogeneity of goods” criterion allows us to identify whether or not the tour is dedicated to one
type of supply-chain. Thanks to the data about the nature of goods being transported, the type of
establishment served and the nature of the operator of the tours, three tour profiles were identified:
beverages distribution, non-perishable food transportation, finished industrial products transportation
and intermediate industrial goods transportation.

5. Non-perishable food transportation does not require the use of specific vehicle, but food
products are often transported with other kind of vehicle, for several reasons. Firstly, because
of specific regulations on food product transportation. Secondly, because of the high level of
concentration of the food retail industry. In parallel with the centralization of retail power
from the 1970s to the 1990s, all major retail companies adopted a centralized distribution
model (Stephens, 2010). Therefore, each retail chains deliver their own stores from their own
regional distribution centers, whereas these regional distribution centers are delivered by the
food industrialist from their food processing structures and commodities. The tours were
assigned, for embarked surveys, with the “non-perishable food” tour profile if all the goods
they transport are “food products”. For the other types of surveys, we used the Naf code of the
transport operator. 78 tours were assigned with this profile among the 771 remaining tours.

6. The catering companies need to replenish their establishments regularly with a wide range of
beverages. Therefore, they can use their own vehicle to supply in cash and carry wholesale
stores, of be delivered by specialized beverage distributors. Two distributors concentrate most
of the beverage distribution market shares in France: France Boissons (a subsidiary of the
Dutch brewing company Heineken) and C10 (a network of 185 independent distributors). The
tours were assigned with the “beverages” tour profile if all the goods they transport are
“beverages”, for the embarked tours. For the other types of surveys, we used the Naf code of
the transport operator. 43 tours were assigned with this profile among the 693 remaining tours.

7. The production of industrial goods is rarely made in one integrated production unit; it
generally requires the transportation of intermediate industrial products between several
production units. These intermediate products can be transported along with other goods, or be
the object of transport operations dedicated to these products. In this case, the transport
operation only serve industrial establishment. It can be made by the primary producer
(shipper) or the secondary producer (receiver), or can be subcontracted to a third party
specialized in goods transportation. The tours were assigned with the “industrial” tour profile
if all the establishments served are “industrial sites”. 56 tours were assigned with this profile
among the 650 remaining tours.

8. Finished industrial products are rarely sent directly by the manufacturers to the customers, and
are rarely transported directly from the manufacturers’ facilities to the customers’ home. They
generally transit via a wholesale distributor, before being delivered to stores (evenly to
retailers’ distribution centers) or other locations (offices, workshops...). Wholesalers are more
or less specialized in one type of products (electric material, furniture, home decoration
products...), and therefore supply more or less specific locations (specialized retailers, offices...). The tours were assigned with the “Finished industrial products” tour profile if the operator of the tour is a “wholesale distributor” (identified with NAF code). 28 tours were assigned with this profile among the 594 remaining tours.

The “service provided” criterion, allows us to identify whether or not the tour belongs to a bulking network, and if yes which service the tour provides in the network. The “general goods” transportation can be done with only one transport operation (end-to-end operation), without any transshipment (figure 1), or can be divided in at least three transport operations (pick-up, line haulage, delivery – evenly with joint pick-up and delivery tours), with at least two transshipment between the different transport operations (figure 2). Thanks to the data about the type of establishment served by the tours (logistics facilities or other facilities) and the type of operations made at these establishments (pick-up or delivery), two tour profiles can be identified: end-to-end transportation and line haul.

![Figure 1 - End-to-end transportation](image)

9. In France, the profession of “coursier” refers to the act of transporting some goods from one point of abduction to one point of destination, without any transshipment or bulking (“end-to-end transportation”). This market is occupied by companies specialized in urgent end-to-end transportation and sometimes specialized in one kind of goods (administrative documents, high value products...). To match with the goods transported and the geographic scale of the operation, the “coursiers” can use a large range of vehicles, from tractor-trailer to bikes (mostly light vehicle in urban areas). They can operate step by step (product 1 in figure 1), or in tours (products 2 and 3 in figure 1). This activity is important in business and administrative districts. The tours were assigned with the “end-to-end” tour profile if, during the whole tour, they pick-up and deliver the same number of goods, and the whole weight of the goods picked-up match with the whole weight of goods delivered, for the embarked surveys. We also used the Naf code of the transport operator for other surveys. 44 tours were assigned with the “end-to-end” profile among the 566 remaining tours.
10. In bulking networks, the shipment of goods requires at least five operations, of which at least two cross-dock operations between three transport operations: pick-up tours (serving the shippers establishments), line-haul (between the carrier’s terminals) and delivery tours (serving the receivers establishment). For a shipment in a hub and spoke network for example, at least seven operations, of which at least four transport operations, can be distinguish: picking-up tour, cross-docking at the shipping terminal, primary line-haul, cross-docking at the central hub, secondary line-haul, cross-docking at the receiving terminal and delivering tour. The major advantage of bulking networks is that it enables carriers to obtain substantial economies of scale, with consolidated transport between terminals (line hauls). Line hauls can serve only two terminals or more. The tours were assigned with the “line haul” tour profile if, during the whole tour, there are as many pick-up operations as delivery operations, the whole weight of the goods picked-up match with the whole weight of the goods delivered, and all the locations served are logistic facilities. We could only use the embarked surveys for these tours. 22 tours were assigned with the “line haul” profile among the 522 remaining tours.

The “type of packaging” criterion allows us to identify in which bulking network the pick-ups and/or delivery tours belong. Three types of bulking network can be distinguished depending on the packaging of the goods transported (pallets, parcels, both pallets and parcels). Therefore, thanks to the data about the type of packaging, three tour profiles can be identified among the tours dedicated to pick-up and delivery in bulking networks: parcels pick-up and/or delivery tours, pallets pick-up and/or delivery tours and mixed (pallets, parcels and other kind of packaging) pick-up and/or delivery tours.

11. Express parcel delivery networks emerged in France in the 1990s, along with the integration of the European market and the arrival of integrators in France. Before, parcels were transported along with other kind of goods in generalist bulking networks, or by the French public postal service company (which remain the largest parcel delivery company in France). Nowadays, even if generalist bulking networks offer the same kind of services in terms of delivery time and traceability, integrators remain specialized in parcel delivery in France. Many reasons are advance by experts to explain the existence of this specific market: parcels permit the automatization of a large part of the cross docking operations, allow the carriers to use smaller vehicles, facilitate the handling operations… The French market of parcel delivery is highly concentrated, with very few networks after two decades of mergers and acquisitions,
including household names such as Geopost (French postal company), DHL, TNT, and UPS. All these companies share the same commercial policy, with a billing per parcel depending on the weight of the parcel and the destination of the parcels (with, for example, three different bills for a shipping of three parcels to and from the same locations). The tours were assigned with the “parcel” tour profile if, during the whole tour, goods picked-up and delivered are all parcels. We could only use the embarked surveys for these tours. 40 tours were assigned with the “parcel” profile among the 500 remaining tours.

12. Bulking networks specialized in pallets deliveries emerged late in France in comparison with Germany or the United-Kingdom. Most of the pallets networks have been set up in the late 2000s and the early 2010s. Palletized goods were transported along with other kind of goods in generalist networks. Experts agree that the success of networks specialized in palletized goods is due to the easier handling of pallets for loading and unloading and for cross-docking operations; and the commercial policy shared by all the actors of this new market, with a billing per pallet depending on the destination of the pallet, regardless of the weight of the pallet. Thus, in pallets bulking networks, pallets are both handling units (supply side) and tariff units (demand side). Two kind of pallets networks can be distinguish in France : integrated networks, which are divisions of major French transport and logistics groups and grouping of SMEs, gathering tens of different companies sharing service requirements The tours were assigned with the “pallets” tour profile if, during the whole tour, goods picked-up and delivered are all pallets. We could only use the embarked surveys for these tours. 15 tours were assigned with the “pallets” profile among the 460 remaining tours.

13. In between parcels and pallets bulking networks remain in France generalist bulking networks, corresponding to what is traditionally called the “messagerie” sector in France. These networks transport any goods of less than 3 tons, regardless of their packaging. With the emergence of specialized bulking networks (parcels and pallets) and the central distribution models developed in the retail industry, most of the generalist bulking companies merged or collapsed. The market is mainly occupied by Geodis and DB Schenker, along with few private companies (divisions of international groups as Kuhne & Nagel and Dachser, and French family-owned companies as Heppner and Mazet). All these companies share the same commercial policy, with a billing per shipment, depending on the total weight of the shipment and the destination of the shipment. Therefore, the services provided by these companies can still be attractive for the shipping of consignments composed of both pallets and parcels, for the shipping of parcels that are too heavy or too large to fit with the parcels networks standards, for the shipping of isolated or light pallets, or for customers who want to work with only one transport service provider. 91 tours were assigned with the “mixed” profile among the 445 remaining tours.

Therefore, a total of 546 tours were assigned with a profile out of 900. The remaining 354 tours could not be profiled, because of insufficient data.
The shape of freight tours: descriptive statistics and visual representation

Table 2 shows basic statistics (average and standard deviation) for each of those variables. In order to understand the freight tours’ impacts on the urban environment, we also take into consideration the duration of the total trip, and the average parking duration during operation of deliveries and pick-ups, as well as the Gross Vehicle Weight Rating (GVWR), expressed in tons and indicating the size of the vehicle.

The data is the driver survey introduced in section 2. For each type of supply-chain, we have the number of observed tours, as well as the number of company in the survey. This is important, because if there are very few companies, it is difficult to draw conclusions on whether the shape of the tour is due to general characteristics of a supply-chain or to the internal organization of a company. In this section, we also chose to depict the different types of tours in a visual manner. It makes it easier to appreciate the different existing patterns.
### Table 2 – Descriptive statistics of the freight tours (weighted) according to the typology

<table>
<thead>
<tr>
<th>Variables</th>
<th>Desc.</th>
<th>Stats</th>
<th>Heterogeneous goods</th>
<th>Homogeneous goods</th>
<th>Specific vehicles</th>
<th>Own-account consignee</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Deliveries / pickups</td>
<td>End-to-end</td>
<td>Line-haul</td>
<td>Food</td>
</tr>
<tr>
<td>Number of operations</td>
<td>Ave.</td>
<td>29.9</td>
<td>10.0</td>
<td>3.6</td>
<td>2.7</td>
<td>14.7</td>
</tr>
<tr>
<td></td>
<td>StDev</td>
<td>22.1</td>
<td>5.2</td>
<td>2.3</td>
<td>3.4</td>
<td>1.6</td>
</tr>
<tr>
<td>Total distance of freight tour (km)</td>
<td>Ave.</td>
<td>66.5</td>
<td>97.2</td>
<td>125.4</td>
<td>88.6</td>
<td>73.6</td>
</tr>
<tr>
<td></td>
<td>StDev</td>
<td>38.2</td>
<td>70.0</td>
<td>90.6</td>
<td>86.6</td>
<td>36.0</td>
</tr>
<tr>
<td>Distance travelled to and from the distribution center (km)</td>
<td>Ave.</td>
<td>18.1</td>
<td>23.9</td>
<td>30.4</td>
<td>17.2</td>
<td>23.9</td>
</tr>
<tr>
<td></td>
<td>StDev</td>
<td>11.1</td>
<td>18.3</td>
<td>26.0</td>
<td>13.5</td>
<td>13.6</td>
</tr>
<tr>
<td>Total duration of freight tour (mn)</td>
<td>Ave.</td>
<td>288.6</td>
<td>315.2</td>
<td>319.6</td>
<td>211.02</td>
<td>188.7</td>
</tr>
<tr>
<td></td>
<td>StDev</td>
<td>124.1</td>
<td>142.8</td>
<td>177.5</td>
<td>185.9</td>
<td>97.3</td>
</tr>
<tr>
<td>Average size of the vehicle (GVWR)</td>
<td>Ave.</td>
<td>4.5</td>
<td>13.5</td>
<td>23.5</td>
<td>2.4</td>
<td>26.3</td>
</tr>
<tr>
<td></td>
<td>StDev</td>
<td>4.2</td>
<td>8.2</td>
<td>13.7</td>
<td>3.2</td>
<td>12.2</td>
</tr>
<tr>
<td>Average duration of operations (mn)</td>
<td>Ave.</td>
<td>5.7</td>
<td>15.5</td>
<td>30.6</td>
<td>10.4</td>
<td>35.1</td>
</tr>
<tr>
<td></td>
<td>StDev</td>
<td>7.0</td>
<td>12.3</td>
<td>12.1</td>
<td>6.6</td>
<td>21.9</td>
</tr>
<tr>
<td>Number of tours obs.</td>
<td>-</td>
<td>38</td>
<td>91</td>
<td>15</td>
<td>44</td>
<td>21</td>
</tr>
<tr>
<td>Number of companies</td>
<td>-</td>
<td>19</td>
<td>16</td>
<td>8</td>
<td>12</td>
<td>5</td>
</tr>
</tbody>
</table>

The general shapes of the tours depicted in Figure 4 are completely random. What matters is the visual representation of the tours, using average values of table 2 for the number of points, distance between points, size of the vehicles, and duration of stops. Figure 4 shows the different patterns of freight tours, notably for the three categories of bulking networks: parcels, pallets and mixed. These three types of tours have very different impacts on the urban environment. It seems that there is a sort of spectrum, ranging from parcel tours (plenty of points, small trips, and small vehicles) to pallet tours (few points, long trips and much bigger vehicles), with mixed tours in between. The duration of each stop is also much shorter for parcel tours. It makes sense considering the organization of their respective activities. Parcel tours have to deliver relatively small amounts of goods, so they can deliver plenty of points, in smaller vehicles. The duration of each delivery is also much shorter. Their market is mostly located in the dense area of the agglomeration, so the distance between points is much smaller. Also, parcel industry warehouses are much closer to the center of the agglomeration than other logistics activities (Heitz & Beziat, 2015), so the distance to and from the distribution center is smaller. The pallets are at the opposite range of the spectrum for each variable, with mixed tours in-between.

The pattern of freight tours for line-haul and end-to-end transport is interesting because it is relatively similar: very low number of points delivered and very high distance between points. End-to-end transport operators have to travel long distances in small vehicles because there is no bulking: they have to retrieve a goods and deliver them in the same tour, according to the requests of their clients. Rationalizing tours is very difficult because of the strong time constraint. On the other hand, line-haul tours are done using much bigger vehicles. The average duration of operations is much longer.
Figure 4 also shows the “homogeneous goods” freight tours. Even within the food sector, there are important differences in their patterns. There is more distance between points for the fresh food sector, because the demand is slightly more specialized than dry foods or beverages, and therefore is slightly more dispersed. The beverage demand is highly concentrated in the center of the agglomeration: these freight tours deliver restaurants, bars, and hotels. This explains the lower distances. The average distance from and to the distribution center is also low, because their warehouses are concentrated around the center of the city. The dry food freight tours are between beverage tours and fresh food tours. The demand they meet is not as specialized as the beverage tours: they have to restock primarily
shops, whether they are small shops in the city centers or large hypermarkets in the suburbs, explaining the longer distances. Interestingly, the average distance to and from the distribution center is longer. This is perhaps explained by the fact that a lot of the fry food tours originate from the Rungis National Market, which is about 10 kilometers away from the center of the agglomeration.

Figure 4 shows the freight tours for intermediary products and finished products. Distributors of finished products produce longer tours with more points and less distance between them (Note: we did not have data for the distance to and from the distribution center, because there were no finished products tours in the embarked surveys). It is understandable, considering, that they have to serve small and large shops in the agglomeration. The shape of the tour is relatively similar to that of dry food tours, for example. On the other hand, intermediary products tours, have fewer points: they serve factories and production units, which are very dispersed in the Paris region. The shapes of the tours are not unlike the line-haul tours, which serve distributions centers.

Finally, freight tours that are done by consignees are not well known in general, because data is difficult to obtain (business owners involved in surveys often don’t feel like a part of their activity is actually urban freight). We know that in the urban freight surveys of the 90’s, they were much shorter than other types (Routhier & Toilier, 2007). This is easily explained by the fact that they are operated by small business owners restocking their stores or restaurants, generally in large wholesaling stores such as Metro, or at the Rungis National Market. This explains that the average number of points is very low.

4. Taking other variables into account to model freight tours

Scope of the analysis

Of course, only taking into account univariate analysis of freight tours has its limits, because other factors can explain the shape of freight tours. The proposed empirical analysis requires the use of several explanatory variables. These are either from the driver-survey (see Section 2) of the UGMS, of from external data. We grouped the different variables in several categories: transport operators, demand, space and logistics organization.

In order to describe the two chosen indicators (number of points of a freight tour and distance between two points of a tour), we used two multiple regression models, estimated using the ordinary least square methodology, which is generally expressed as:

$$ Y = \beta_0 + \sum_{i=1}^{n} \beta_i X_i + \varepsilon $$

Where $Y$ is a dependant variable (number of points or distance between points), and $X_i$ is a vector of explanatory variables. Parameters $\beta_i$ have to be estimated in order to predict accurately the value of variable $Y$. Our aim is not to predict values, but simply to see how coefficients $\beta_i$ will be estimated (what sign and what value).
Table 5 gives the results of our first model (for the number of points of a freight tour). For each variable, the table gives an estimation of the value of the coefficient, its t-stat and statistical significance. The table also gives the performance of each model with the adjusted $R^2$. For both tables, the statistical significance level is measured by the p-value: *** means p-value < 0.001; ** means p-value < 0.01; * means p-value < 0.05; - means p-value < 0.1.

### Table 5 – Results of the first model (number of operations)

<table>
<thead>
<tr>
<th>Name</th>
<th>Value of parameters</th>
<th>Type of variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>11.967 (8.76)**</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Duration</td>
<td>0.016 (8.16)**</td>
<td>Control</td>
<td>Duration of freight tour (in minutes)</td>
</tr>
<tr>
<td>Turnover</td>
<td>0.003 (5.04)**</td>
<td>Company</td>
<td>Turnover of the company doing the transport (thousands of €)</td>
</tr>
<tr>
<td>Dist_Dest_ave</td>
<td>-0.085 (-3.09)**</td>
<td>Spatial</td>
<td>Average distance of the destinations of the trips of a tour to the center of the agglomeration</td>
</tr>
<tr>
<td>% prox activities</td>
<td>2.656 (2.60)**</td>
<td>Demand</td>
<td>The percentage of businesses reached by the tour which can be considered &quot;proximity activities&quot; (shops, retail, offices) vs. &quot;basic activities&quot; (industry, warehouses)</td>
</tr>
<tr>
<td>Mgt_mode_own account</td>
<td>-2.44 (-2.32)**</td>
<td>Company</td>
<td>Management mode of the company doing the transport operation (own account vs. third party)</td>
</tr>
<tr>
<td>Vehicle_rigid_truck</td>
<td>-3.506 (-3.61)**</td>
<td>Log. Org.</td>
<td>Rigid trucks, &gt; 3.5 T (compared to light goods vehicles (&lt; 3.5T)</td>
</tr>
<tr>
<td>Vehicle_artic_lorry</td>
<td>-6.184 (-4.79)**</td>
<td>Log. Org.</td>
<td>Articulated trucks, &gt; 3.5 T (compared to light goods vehicles (&lt; 3.5T)</td>
</tr>
<tr>
<td>Typo_mixed</td>
<td>-3.585 (-2.89)**</td>
<td>Log. Org.</td>
<td>Mixed bulking networks (compared to parcels bulking networks)</td>
</tr>
<tr>
<td>Typo_end to end</td>
<td>-10.764 (-8.21)**</td>
<td>Log. Org.</td>
<td>End-to-end networks (compared to parcels bulking networks)</td>
</tr>
<tr>
<td>Typo_line haul</td>
<td>-6.888 (-4.05)**</td>
<td>Log. Org.</td>
<td>Line-haul transportation (compared to parcels bulking networks)</td>
</tr>
<tr>
<td>Typo_dry food</td>
<td>-2.324 (-1.40)</td>
<td>Log. Org.</td>
<td>Dry food distributors (compared to parcels bulking networks)</td>
</tr>
<tr>
<td>Typo_beverage</td>
<td>-4.600 (-2.42)**</td>
<td>Log. Org.</td>
<td>Beverage distributors (compared to parcels bulking networks)</td>
</tr>
<tr>
<td>Typo_fresh food</td>
<td>-5.779 (-3.91)**</td>
<td>Log. Org.</td>
<td>Fresh food distributors (compared to parcels bulking networks)</td>
</tr>
<tr>
<td>Typo_finished prod</td>
<td>-6.542 (-4.71)**</td>
<td>Log. Org.</td>
<td>Finished products distributors (compared to parcels bulking networks)</td>
</tr>
<tr>
<td>Typo_specific veh</td>
<td>-7.948 (-4.16)**</td>
<td>Log. Org.</td>
<td>Specific vehicles - cars and concrete (compared to parcels bulking networks)</td>
</tr>
</tbody>
</table>

Number of obs. 333
R² 0.5652
Adjusted R² 0.5432

Table 6 gives the results of our second model (for the distance between two points of our freight tour). The format is the same as before.

### Table 5 – Results of the second model (distance between operations)

<table>
<thead>
<tr>
<th>Name</th>
<th>Value of parameters</th>
<th>Type of variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-8.019 (-3.58)**</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nb of points</td>
<td>-0.168 (-4.39)**</td>
<td>Control</td>
<td>Number of points of a freight tour</td>
</tr>
<tr>
<td>Turnover</td>
<td>-0.002 (-4.84)**</td>
<td>Company</td>
<td>Turnover of the company doing the transport (thousands of €)</td>
</tr>
</tbody>
</table>
Dist_Dest -0.477 (19.34)***
Spatial Distance of the destination of the trip to the center of the agglomeration

Type_link: princip. 13.088 (21.56)***
Control Trips from and to the distribution center (compared to "ordinary trips")

Type_tour: round 10.044 (5.56)***
Log. Org. Freight tours done in rounds (compared to freight tours done in single trips)

Vehicle_rigid_truck -3.050 (-3.45)***
Log. Org. Rigid trucks, > 3.5 T (compared to light goods vehicles (< 3.5T)

Vehicle_artic_lorry 0.198 (0.15)
Log. Org. Articulated trucks, > 3.5 T (compared to light goods vehicles (< 3.5T)

Typo_mixed 2.407 (2.504)*
Log. Org. Mixed bulking networks (compared to parcels bulking networks)

Typo_pallets 7.849 (4.48)***
Log. Org. Pallets bulking networks (compared to parcels bulking networks)

Typo_end_to_end 3.518 (2.55)*
Log. Org. End-to-end networks (compared to parcels bulking networks)

Typo_linehaul 3.547 (1.88)*
Log. Org. Line-haul transportation (compared to parcels bulking networks)

Typo_dryfood 5.618 (4.91)***
Log. Org. Dry food distributors (compared to parcels bulking networks)

Typo_beverage 1.708 (1.28)
Log. Org. Beverage distributors (compared to parcels bulking networks)

Typo_freshfood 5.495 (4.79)***
Log. Org. Fresh food distributors (compared to parcels bulking networks)

Typo_finishedprod 8.683 (7.35)***
Log. Org. Finished products distributors (compared to parcels bulking networks)

Typo_specificveh 6.554 (2.70)**
Log. Org. Specific vehicles - cars and concrete (compared to parcels bulking networks)

Number of obs. 2,441

R² 0.3721

Adjusted R² 0.3679

Discussion of results

Variables of the transport company: the turnover of the companies has a positive influence on the number of points and the distance travelled between points, suggesting that bigger freight operators might have the ability to streamline their freight tours more efficiently. In the case of the total number of points, the management mode also has its importance: all things being equal, own-account tours have fewer points than third-party tours. The distinction was not significant for the distance between points.

Demand-driven variables: the type of establishment delivered mainly had an impact on the number of points of a tour. Tours that have a high ratio of “proximity” establishments (shops, offices, services) in their path touch more points than other tours. The distinction was tested for the distance between points, but the results were not significant.

The role of spatial variables: interestingly, the spatial variables had a significant impact in both models. Generally, lower average distance of a tour to the city center means more points connected by the tour. Parallel, a trip connecting an establishment closer to the city center is much shorter. The other variable, the distinction between “principal” trips, and “main” trips of a tour, was extremely significant. It’s actually the highest coefficient of the second model. Obviously, links from and to the distribution centers are much longer than links between establishments within a tour.

Finally, the logistics organization of supply-chain: firstly, it refers to the type of vehicles. The type of vehicle did not make a significant statistical impact in all models, but generally, the following
conclusions were drawn: rigid trucks touch fewer points than light goods vehicles, and the coefficient is even lower for articulated lorries. For the second model, rigid trucks travelled fewer kilometers between points than light goods vehicles, while articulated lorries travelled more kilometers. But the variables are not statistically significant in all models, so the results are inconclusive. Then our supply-chain typology was tested with dummy variables in all the models. What is interesting is that most categories were statistically significant in almost all models and specifications. Obviously, the parcel tours had the most points and the least distance between points, therefore all of the coefficients’ signs are negative. But depending on the value of the coefficient, all things being equal in the model, we can rank the different tours according to their number of points. In the first model, from most points to least: parcels, mixed, beverage, fresh food, finished products, line-haul, specific vehicles, pallets and end-to-end. And we can rank the tours according to the distance between points, from least to most: parcels, mixed, end-to-end, line-haul, fresh food, dry food, specific vehicles, pallets and finished products.

5. Conclusion: policy and theoretical implications

There are many possibilities for the urban authorities to manage urban freight and its impact: last-mile strategies, environmental strategies, trade node strategies (Dablanc et al., 2012). The effectiveness of alternative strategies and their transferability in different urban areas differ according to the logistic profile of each UGM. On the other hand, the externalities generated by UGM (congestion, air pollution, noise or greenhouse gas emissions) depend on their operational characteristics, themselves linked with their logistics profiles. Therefore, knowledge of freight tours is a requirement to provide an understanding on freight operations and their externalities, and to monitor the effects of policy measures (Allen et al, 2014; Holguin-Veras & Jaller, 2014).

Our paper follows a relatively descriptive approach: in section 2, we explained the nature of the data we used for this analysis. This type of data, in particular the embarked surveys, are in our opinion mandatory tools to understand the shape of freight trips in an urban agglomeration. Anything less than this level of detail makes it difficult to understand the formation of freight tours. In section 3, we used our knowledge of freight operators (coming from interviews and the literature) to profile the tours according to their operational characteristics. We also describe very different patterns, according to their profiles. Finally, in section 4, we tried to explain the shape of these tours using other different variables.

We believe that this understanding of the variety of logistics organization is necessary in order to go further in the modeling of urban freight. It has focused a lot, in the past 40 years, on understanding the generation of the demand created by the shippers. We need to understand the characteristics of the supply of goods transport, if we wish to make (1) a correct assessment of the impacts of urban road transport and (2) if we want to predict what the impacts would be if the current system is changed by policies. The French Freturb Software (Routhier & Toilier, 2007) already uses the kind of data we used to model freight tours, taking into account the types of vehicle, the management modes, the type of activity of served establishments, the size of the tours, the distance to the city center… This work provides an attempt to enrich this approach with knowledge of the logistics organizations of transport operators.
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