Final Report

Indicators and data collection methods on urban freight distribution

Non-binding guidance documents on urban logistics
N° 6/6

Authors:
van den Bossche, M. and Maes. J. (Ecorys)
Vanelslander, T. (University of Antwerp)
Macário, R. and Reis, V. (University of Lisbon)
with contributions from experts:
Dablanc, L.

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E-mail: MOVE-B4-SECRETARIAT@ec.europa.eu

European Commission
B-1049 Brussels

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Table of Contents

Glossary and abbreviations

APNR:	Automatic Number-Plate Recognition
B2B:	Business to Business
B2C:	Business to Consumer
CATI:	Computer-Assisted Telephone Interviewing
FUME:	Freight Urban Mobil Equipment
GNSS:	Global Navigation Satellite System
LTG:	Large Traffic Generator
SUMP:	Sustainable Urban Mobility Plans

Chapter 1 Introduction

Non-Binding Guidance Documents

This document is one of a series of six Non-Binding Guidance Documents (NBGDs) prepared within the scope of the Study on Urban Mobility - Preparation of EU guidance on Urban Logistics (MOVE/C1/2014-370) as commissioned by the European Commission. The documents aim to help stakeholders understand the challenges brought about by logistics activities in an urban context, and identify the most suitable measures and actions to overcome these challenges.

This non-binding guidance document (N° 6 of 6) covers the issue "Which data is needed for urban logistics policy-making and how can data be collected". The document provides specific information on the various data that can be collected, their purpose and the best means of collection.

Collecting and treating urban logistics data

Policymakers need data about urban freight distribution to set up their related policy. When only a limited amount of data is available, authorities have too little insight into urban freight operations to develop strategies and take policy measures. More information contributes to a better design and usage of the infrastructure, a better estimation of potential costs and benefits of new projects. and better monitoring of freight transport performance. Moreover, possessing relevant and accurate data is important for communication purposes in the sense that politicians can better understand reality on the basis of specific data, and thus strive for good governance. The Urban Freight research roadmap [1] states that data collection is a crucial step for any relevant urban logistics research agenda.

The European policy making process and the role of data collection are discussed in the Sustainable Urban Mobility Plans (SUMP). 11 steps are identified in the SUMP, of which four address data collection [2]: analyse the mobility situation and develop scenarios (preparation); set priorities and measurable targets (goal setting); build monitoring and assessment into the plan (elaboration); learn the lessons (implementation).

Urban freight distribution data collection has gained increased attention in recent literature. Few authors have made the link between urban freight collection methods and indicators. Only a few broad indicators are given and no examples of data collection efforts measuring these indicators are provided. Moreover, stakeholders often do not know whether the indicators they commonly use are potentially useful indicators.

This report gives an overview of the urban freight distribution data, means of collecting them in a focused way and assistance in determining the city's urban freight distribution profiles. More specifically, the objectives of this paper are twofold. The first objective is to determine the common indicators needed in an urban freight context. The overview of indicators allows for the identification of different profiles (see 'delivery profiles' further in this document), so that data can be collected in a more focused way. The second objective is to discuss the common data collection methods used to obtain these indicators. In addition, examples of case studies measuring specific indicators and using certain collection methods are included in order to provide an overview of interesting sources for each indicator and method.

The goal of these Non-Binding Guidance Documents (NBGD) is to support local authorities who are planning to collect urban logistics data, by providing non-binding guidance. The guidance is primarily aimed for use by public authorities such as municipalities or local agencies responsible for the management of the traffic, transport and transport infrastructures within urban areas. Logistics and freight transport operators with operations in cities may also benefit from this document. More in-depth examples, references and practical guidance can be found in the fully referenced Technical Report on which this less technical NBGD is based.

Chapter 2 Challenges in collecting urban freight data

This Chapter discusses the lack of available data, based on an extensive study of available literature, which also includes considerable stakeholder consultation. Firstly, some general observations of the literature are commented on. Secondly, some case studies of Western-European countries are briefly discussed. This Chapter concludes by listing the main shortcomings in data on urban freight distribution.

2.1 General observations

Since the beginning of the 21st century, the availability of data on urban freight distribution has only slightly improved. The improvements are the result of new national freight surveys in some countries, or data collection efforts at local urban level. One of the most important data collection initiatives in Europe took place in France, in around 1997. This initiative was executed with the help of government financing. In 2011-2012, a new survey round was set up for the city of Paris [3]. Four main observations are derived from existing data collection efforts.

Firstly, it is pointed out that **freight transport** in general is **neglected** in many surveys and models. More specifically, it is observed that parameters such as type of goods, packaging, delivery frequency and type of vehicle, which are needed to reflect the urban freight reality, are not available in common statistics.

Secondly, the **lack of data at urban level** is indicated. Moreover, the lack of sufficient representative surveys on urban freight distribution and the difficulty in estimating the importance of urban freight transport are also highlighted. Note that national surveys are carried out in many countries, but they often fail to contribute to an extended knowledge of urban freight distribution, for different reasons. A sample in an urban area is generally small, and thus statistically not representative. Furthermore, it is difficult to extract data from a general dataset when data in national surveys do not deliver the detailed information necessary for the analysis of urban freight distribution.

Thirdly, it is observed that data collection methodologies are not systematic; different **data cannot be compared** to each other. Data on urban freight transport are often incompatible with data on freight transport between cities. Other reasons for the incompatibility of data are collection by diverse institutions or authorities, and the fact that different countries use different definitions for 'urban goods movement'.

Fourthly, in cases where urban freight distribution data are available, they are often **not analysed** due to the fact that this is both expensive and complex. In addition, it is stated that the existence of the available data is often unknown. The reasons for this are that data are not all preserved at the same location and that they frequently belong to reports formulated in national languages, or that the existing data are not made publicly available.

In brief, it is observed that data collection initiatives are not carried out in a systematic way. Therefore, the following chapters provide an overview of indicators that characterise urban freight distribution, as well as common methodologies used to collect these indicators. (Local) authorities play an important role here in turning the indicators and collection methods into a generic framework that is used by the main stakeholders. Hence, the results of the framework can be translated into a policy based on systematic data collection.

2.2 Case studies

This section refers to a selected set of case studies, analysed as part of specific projects.

In 2006, the **BESTUFS project** was executed. This project had as its objective to identify and to spread case studies concerning urban freight distribution. Within the context of this project, several reports on urban freight data collection were published. For every participating country[1], an overview was provided of past transport policies and data collection initiatives.

One of the conclusions for ***Belgium*** is that no urban freight indicators are collected and the knowledge on urban freight distribution is limited. Most indicators collected are general indicators, such as the average transport distance of Belgian freight vehicles, the total number of accidents of freight vehicles on motorways, etc. Most freight data are collected at national level, leading to less attention at the urban level. In terms of small freight vehicles in particular, only limited data are available, and there is also little knowledge regarding the organisation of urban freight transport.

The main data gaps in ***France*** include the following: Firstly, there is not enough knowledge of traffic flows generated by urban freight distribution. Secondly, only limited data on the costs resulting from urban freight distribution are available. Thirdly, the available data are often outdated. Fourthly, many local surveys exist, however the results are not synchronized. Consequently, no best practices can be deducted from different experiments and too little data exists on commuting traffic, waste and reverse logistics, network management and flows generated by urban public management.

In ***Germany***, a lack of data is particularly notable concerning the following: the use of small utility vehicles of <3.5t, freight transport by foreign vehicles, transport flows within and between agglomerations, the use of roads by commercial transport, reasons for accidents involving utility vehicles in a city, data on parking fees, parking spaces for freight vehicles, road taxes, city taxes, etc., as well as data concerning the use of energy and CO2-emissions by utility vehicles. Data collection on urban freight distribution is the responsibility of cities and regions themselves. The government does not coordinate data collection centrally, but offers financial incentives. In general, little data are available. Where data are available, they are frequently in the hands of private companies such as logistics service providers and couriers, and thus often not publicly accessible.

In ***The Netherlands***, it is concluded that no reliable public data with respect to urban freight distribution are available. Problems when collecting data are the lack of financial resources and the small size of the samples used in surveys. The main shortcomings are that (1) urban freight is not well represented in existing statistics, (2) national Origin/Destination data are limited if disaggregated for certain urban areas, (3) only limited information on trip frequency, time, vehicle type, etc. exists, and (4) no information on rail and inland waterways exists within the context of urban freight distribution. Subsequently, only a limited part of the data is published at urban level. However, these data do not provide information on how the goods are transported. Finally, traffic counts exist, but freight transport is often not a separate category in these counts.

In the latest acceded Member States of the EU[2], only limited data concerning freight transport are available, whereas the first acceded Member States investigated in the research[3] feature

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[1] The countries for which this information is available are Belgium, France, Germany, Hungary, Italy, The Netherlands, Portugal, Spain, Sweden, Switzerland and the United Kingdom.
[2] In this research these were more specifically the cities Gdynia (Poland) and Kaunas (Lithuania).
[3] The cities Bremen (Germany) and Örebro (Sweden) are the subject of research in the work of Lindholm & Behrends [74].

somewhat more urban freight distribution data. However, the objective of the data is just the optimisation of the traffic and not the use of the data at strategic level.

The **CITYLAB project** has been running since 2015. The objective of this project is to gain knowledge on urban last-mile deliveries, large freight attractors and public administrations, urban waste and reverse logistics, and logistics facilities and warehouses. Cities acting as living labs include Amsterdam, Brussels, London, Oslo, Paris, Rome and Southampton [4].

The **NOVELOG project** has been running since 2015, and will conclude in 2018. This project helps the involved cities increase their awareness of urban freight distribution. Several cities in countries across Europe are participating in the project[4] [5].

Another project that started in 2015 is the **SUCCESS project**. This initiative investigates solutions for construction sites urban freight transport. Cases are elaborated on in four cities: Luxembourg (LUX), Paris (F), Valencia (ES) and Verona (IT) [6].

Finally, there is the **URBACT network**, in which cities are enabled to cooperate in order to develop sustainable best practices and to share them. 29 countries and 550 cities are involved in the network [7].

2.3 Main shortcomings in data

Table 1 lists the main gaps in available data. Full details and an explanation of the various concepts is given in the following sections. With regard to urban freight distribution, these main gaps are data concerning empty flows, activities of lorries <3.5 tons, speed and (geographic) route data, loading and unloading operations, choice of transport mode and data on transport modes other than road transport. To this list can be added data on trip distances and patterns, including which freight types use which infrastructure elements, as well as data on impacts and externalities.

Table 1 Main data gaps

Data category		Availability
Freight generation data	Production	No data collected till present
	Consumption	
Delivery tours	Sequence	Only GNSS data from private suppliers
	Location	Limited level of detail
	O/D[5] flows	No full information
	Empty flows	No data
	Activity of trucks <3,5t	No data
	Speed and (geographic) route data	No data

[4] Test cases are executed in Athens (EL), Barcelona (ES), Copenhagen (DK), Emilia-Romagna Region (IT), Gothenburg (SE), Graz (AT), London BDD (UK), Mechelen (BE), Pisa (IT), Rome (IT), Turin (IT), Venice (IT).

[5] O/D is the abbreviation of Origin/Destination.

	Loading and unloading operations	No data
Economic characteristics of participating agents	Shippers	Few sources, but no complete image; data do not have added value compared to other data categories
	Carriers	
	Receivers	
Spatial distribution/ location of participating agents	Shippers	
	Carriers	
	Receivers	
Network characteristics	Travel times and costs	Limited level of detail
	Use restrictions	
	Capacity	
	Traffic volumes	
	Complete *supply chain*	No data
Special choice processes	Mode choice	No data
	Other modes than road	No data
	Delivery time	Limited level of detail
	Mode attributes	Reasonable level of detail
Other economic data	Production functions	No data
	Demand functions	
	Input-output technical coefficients	Strong level of detail, e.g. Regional Economic Information System (US) and the Benchmark Input-Output Accounts (US)
	Shopping trips of customers	No data
	Methodology, data collection, reliability and representability of data	Limited information

Source: Own composition based on [8], [9], [10], [11]

This Chapter show that there is currently a lack of representative data on freight, particularly within an urban context. Therefore, the next Chapter examines in more detail the type of data that should be collected, as well as the methods of collection. In addition to the conceptual indicator typology, examples from various countries, European and non-European, are given, which show how different countries and cities deal with data collection.

Chapter 3 Urban logistics indicators

In the second stage of the analysis, the type of data needed to understand urban freight distribution is described in more detail. Therefore, this Chapter classifies the possible urban logistics data according to an urban freight profiles framework, into a typology.

Urban freight distribution can be classified by producing clusters of urban freight distribution data. Schoemaker et al. [12] split urban freight distribution into six impact factors, these being: freight volumes and commodities in urban areas, urban freight transport fleet, urban deliveries, and contributions to, respectively, the economy, the environment and safety. Another classification, used by the Flemish cities and municipalities, is given by the following six sub-categories: shop profile, delivery profile, transport profile, analysis of logistics rules, stakeholder analysis and other data[6]. This line of thought was used in previous research and is also followed here. Janjevic et al. [13] state that logistics profiles are characterised by a collection of indicators. Therefore, the aim is to give for each of the six sub-categories an overview of indicators that are commonly used to describe that category. General transport indicators that are used for long distances, such as tonnage, tonne-kilometres, etc. are to a lesser extent relevant at an urban level [14]. Therefore, the indicators in this Chapter result from a review of literature on urban freight distribution.

Table 2 gives an overview of the urban indicators that are mentioned in literature[7]. This is a comprehensive summary of all possible indicators that may apply to any possible type of urban logistics decision one wants to support with data analysis. For each indicator, a proposed data collection method is mentioned, as well as an application of the data collection in a specific country and the scientific source providing information on the indicator.

[6] The shop profile comprises the location of different shops; the delivery profile incorporates the timing, frequency, location, parcel size, shipper, etc. of the deliveries; the transport profile defines the type of transport operator, the sector, the type of load, type of vehicle, load factor and bundling; the analysis of logistics rules includes time windows, pedestrian zones, loading and unloading zones, etc.; the stakeholder analysis equals the different stakeholders involved, as well as the analysis of their requests and bottlenecks; the other data collection tackles other types of datasets [75].

[7] This overview is non-exhaustive, but comprises the main sources on urban freight data collection in literature. The indicators are ranked alphabetically per profile, and only cells for which the information was found, are filled in.

Table 2 Overview of urban freight indicators by sub-category

Indicator	Method	Example	Source
Analysis logistics rules			
Environmental zones	Carrier survey, freight associations survey, local-decision maker survey	London (2015), Berlin (2015)	[15], [16], [17]
Loading/unloading zones	Carrier survey, driver survey, in-depth focus groups	Rome (2010), New York (2014)	[15], [18], [19], [20], [21]
Noise emissions			[15]
Off-peak deliveries	Carrier survey, delivery space observation, driver survey, establishment survey, GNSS data collection, in-depth focus groups	New York (2014), Brussels (2016), Stockholm (2015)	[22], [23], [24]
Availability of loading/unloading zones	Delivery space observation, driver survey	New York (2014)	[18], [25]
Road pricing	Carrier survey, delivery space observation, driver survey, establishment survey, GNSS data collection, in-depth focus groups	Rome (2010), New York (2010)	[18], [26], [22]
Size limitations (length, height)	Local-decision maker survey, shipper survey		[15], [27]
Time windows	In-depth focus groups, carrier survey, driver survey	Rome (2010)	[15], [18], [27], [28]
Urban consolidation initiatives	Carrier survey, in-depth focus groups, shipper survey, supplier survey	Brussels (2012), The Hague (2010)	[29], [30], [31], [32]
Weight limitations (total or per axle)	Carrier survey, shipper survey, road sensors		[15], [33]
Delivery profile			
Delivery frequency	Carrier survey, driver survey, establishment survey, receiver survey, vehicle observation	Bordeaux, Dijon, Marseille (1997), Budapest (1999), Milan (2002), Medan (2006)	[12], [15], [34], [35]
Loading/unloading share for own account	Urban goods movement survey	Bordeaux, Dijon, Marseille (1997), Breda (2008)	[34], [36]
Load value	Driver survey		[34]

Indicator	Method	Example	Source
Location of stops	Carrier survey, delivery space observation, driver survey, establishment survey, GNSS data collection, license plate matching, roadside interview, roadside postcard survey, supplier survey, urban goods movement survey, vehicle diary	Antwerp (1995), Bordeaux, Dijon, Marseille (1997), Liège (2004), Toronto (2006-2007), Breda (2008), New York (2014), Antwerp (2016), Lisbon (2015)	[9], [12], [22], [34], [37]–[45]
Location of consolidation points	Carrier survey, in-depth focus groups, shipper survey, supplier survey	Paris (2012)	[46]
Number of deliveries	Carrier survey, delivery space observation, driver survey, establishment survey, receiver survey, supplier survey	Antwerp (1995), Antwerp (2016), Bordeaux, Dijon, Marseille (1997), Liège (2004), Breda (2008)	[12], [17], [35], [36], [38], [40], [41], [47],[48]
Number of loading/unloading operations per week/employee/activity	Driver survey, shipper survey, supplier survey, urban goods movement survey, vehicle observation	Amsterdam, Utrecht (2002), Rotterdam (2003)	[9], [34], [35], [37], [38], [48], [49]
Number of pieces per drop	GNSS data collection, traffic counts	Rome (2005-2006), Milan (2010)	[50], [51]
Parking infractions	Delivery space observation, driver survey, establishment survey, parking survey, vehicle diary	Liège (2004)	[40], [43], [49], [52]
Parking location (e.g. walking distance)	Driver survey, establishment survey, GNSS data collection, parking survey, traffic counts, service provider survey, vehicle observation	Amsterdam & Utrecht (2002), Rotterdam (2003), Breda (2008), New York (2016)	[12], [18], [25], [34], [36], [38], [43], [49]
Ratio loading/unloading	Carrier survey, establishment survey, urban goods movement survey	Bordeaux, Dijon, Marseille (1997), Breda (2008)	[8], [9], [34], [36]
Reverse and waste flows	Carrier survey, driver survey, receiver survey, supplier survey	Breda (2008)	[12], [36], [38]
Size of the shipment	Driver survey, establishment survey, shipper survey, urban goods movement survey, vehicle observation	Bordeaux, Dijon, Marseille (1997), Liège (2004), Breda (2008), Antwerp (2016)	[14], [36], [38], [40], [44], [48], [53]

Indicator	Method	Example	Source
Service time	Delivery space observation, driver survey, establishment survey, GNSS data collection, parking survey, traffic counts, urban goods movement survey, vehicle diary, vehicle observation	Rome (2005-2006), Milan (2010) Livorno (2003), Liège (2004), Rome (2005-2006), Barcelona (2010), Milan (2010)	[9], [12], [37], [38], [40], [42]–[44], [48], [50], [51], [53]–[55]
Storage space/(re)building plans	Carrier survey, driver survey, establishment survey, receiver survey, supplier survey	Breda (2008)	[36]
Type of transport equipment (e.g. pallets, foldable boxes)	Delivery space observation, driver survey, establishment survey, traffic counts, vehicle diary	Breda (2008), Milan (2010)	[36], [43], [50]
Unloading equipment (e.g. fork-lift truck, pallet transporter)	Carrier survey, delivery space observation, driver survey, establishment survey, urban goods movement survey, vehicle diary, vehicle observation	Liège (2004)	[38], [40], [43], [53]
Use of lorry equipment (e.g. loading bridge)	Delivery space observation, driver survey, establishment survey, traffic counts, vehicle diary, vehicle observation	Breda (2008), Milan (2010)	[36], [38], [43], [50]
Variation of deliveries by hour/ day/ during year	Establishment survey, traffic counts	Bordeaux (1995), Amsterdam, Utrecht (2002), Rotterdam (2003), Dublin (2004), London (2004), Bologna (2004), New York (2014), Lisbon (2015)	[12], [22], [35], [38]
Vehicle trip purpose (e.g. joint or separate delivery and collection)	Carrier survey, driver survey, establishment survey, roadside interview, service provider survey, supplier survey, vehicle diary	New York (2014), Lisbon (2015)	[9], [12], [34], [38], [42], [44], [53]
Shop (B2B) and receiver (B2C) profile			
Company and sector category	Establishment survey, traffic counts, urban goods movement survey	Antwerp (1995), Amsterdam, Utrecht (2002), Rotterdam (2003), Barcelona (2010), Milan (2010), Lisbon (2015)	[9], [34], [35], [38], [41], [44], [47], [50], [54], [56], [57]

Indicator	Method	Example	Source
Location of the shop	Establishment survey, traffic counts	Milan (2010), Lisbon (2015)	[34], [44], [50], [57]
Name of the shop	Establishment survey, traffic counts	Milan (2010)	[50]
Number of employees	Establishment survey, government databases	Antwerp (1995), Medan (2006), Barcelona (2010)	[15], [38], [41], [44], [54], [56]
Number of inhabitants in area (density of demand)	Government databases		[14], [58]
Order lead times	Carrier survey, driver survey, establishment survey, roadside interview, service provider survey, supplier survey		[38]
Presence/signature of and/or control by staff required or not	Carrier survey, driver survey, establishment survey, roadside interview, service provider survey, supplier survey		[38], [22]
Inventory management and strategies	Establishment survey		[38]
Shop size	Establishment survey, government databases	Antwerp (1995), Breda (2008), Barcelona (2010)	[36], [38], [41], [54]
Stakeholder analysis			
Drivers	Roadside interview, roadside postcard survey		[15], [18]
Inhabitants	In-depth focus groups, urban freight forum		[15], [18], [36]
Large transport and logistics firms	In-depth focus groups, license plate matching, roadside interview, roadside postcard survey, urban freight forum		[15], [18], [38]
(Local) governments	In-depth focus groups, urban freight forum, sensors, license plate matching		[59]–[61]
Local shopkeepers (B2B)	In-depth focus groups, urban freight forum	Lisbon (2015), New York (2015)	[14], [15]
Receiver (B2C)	License plate matching, roadside interview, roadside postcard survey		[37]
Shipper	License plate matching, roadside interview, roadside postcard survey	Breda (2008)	[37]
Small operators	In-depth focus groups, license plate matching, roadside interview, roadside postcard survey, urban freight forum	Antwerp (2016)	[15], [38], [48], [50]

Indicator	Method	Example	Source
Transport profile			
Average speed per round trip	Driver survey, GNSS data collection, urban goods movement survey	Gauteng (2008)	[9], [37], [44], [45], [62], [63]
Carrier name	Establishment survey, traffic counts, license plate matching, roadside interview, roadside postcard survey	Bordeaux, Dijon, Marseille (1997), Milan (2010)	[15], [38], [43]
Choice of distribution channels (e.g. own account, logistics company, parcels carrier)	Establishment survey	Bologna (2002), Liège (2004), Antwerp (2016)	[12], [15], [17], [38], [40], [48]
Driver characteristics	Driver survey, service provider survey		[44]
Engine information (speed, rpm, load, acceleration, stops, fuel consumption, euro norm)	GNSS data collection	Toronto (2006-2007)	[34], [43]
Freight type (dangerous, volume, livestock)	Carrier survey, delivery space observation, driver survey, establishment survey, license plate matching, roadside interview, roadside postcard survey, supplier survey, urban goods movement survey, vehicle diary, vehicle observation	Antwerp (1995), Bordeaux, Dijon, Marseille (1997), Bologna (2004), Liège (2004), Toronto (2006-2007)	[12], [34], [38], [40], [41], [43], [44], [53], [64]
Fuel type & consumption	Driver survey	Amsterdam, Den Bosch, Groningen, Tilburg (1999)	[12], [43], [64]
Load factor	Establishment survey, roadside interview, Urban goods movement survey	Amsterdam, Groningen, Tilburg (1999), Budapest (1999), Copenhagen (2002-2004), London (2002), Medan (2006), Barcelona (2010)	[9], [12], [15], [37], [38], [44], [50], [54]
Location of (urban) distribution centres	Carrier survey, government databases, tracking of individual shipments, urban goods movement survey	Paris (2010)	[65]
Number of stops (per round/ per day)	Driver survey, GNSS data collection, urban goods movement survey, vehicle diary	Bordeaux, Dijon, Marseille (1997), Melbourne (2006)	[12], [38], [43], [56], [63]

Indicator	Method	Example	Source
Number of trips	Carrier survey, vehicle observation		[37], [43]
Number of vehicles	Driver survey, establishment survey, traffic counts	Antwerp (1995), London (2004), Bologna (2006), Milan (2010), Rome (2010), Brussels (2012)	[9], [12], [18], [19], [41], [50]
Operation type	Delivery space observation, driver survey, establishment survey, vehicle diary		[43]
Organisation of the transport chain	Carrier survey, tracking of individual shipments, urban goods movement survey		[11], [14], [38], [42], [43], [53]
Package type	Delivery space observation, driver survey, establishment survey, traffic counts, vehicle diary, vehicle observation	Bordeaux, Dijon, Marseille (1997), Liège (2004), Barcelona (2010), Milan (2010)	[14], [38], [40], [43], [53], [54]
Route duration	Driver survey, GNSS data collection, vehicle diary	Bordeaux, Dijon, Marseille (1997), Amsterdam, Den Bosch, Tilburg (1999)	[12], [14], [37], [38], [43]
Route length	Driver survey, establishment survey, GNSS data collection, urban goods movement survey, vehicle diary	Bologna (2002), London (2002), Melbourne (2006), Breda (2008)	[12], [36], [37], [43], [44], [55], [56], [63], [66]
Route type (single trip, round trip)	Carrier survey	Bordeaux, Dijon, Marseille (1997), Amsterdam, Den Bosch, Groningen, Tilburg (1999)	[12], [38], [44]
Routing	Carrier survey, classical survey, driver survey, GNSS data collection, license plate matching, receiver survey, roadside interview, roadside postcard survey, service provider survey, supplier survey, urban goods movement survey, vehicle diary	Bordeaux, Dijon, Marseille (1997), Toronto (2006-2007), Breda (2008), Gauteng (2008)	[14], [36], [38], [43], [44], [49], [50], [62], [63]
Share of loading/unloading with vehicles < 3.5 tons in vehicle movements	Urban goods movement survey	Bordeaux, Dijon, Marseille (1997)	[14], [56]

Indicator	Method	Example	Source
Share of small establishments (< 5 employees) in vehicle movements	Urban goods movement survey	Bordeaux, Dijon, Marseille (1997)	[14]
Stopping manoeuvres	Delivery space observation, driver survey, establishment survey		[43]
Time at different locations along the route	GNSS data collection	New York (2014)	[22], [26], [37]
Transport mode	Carrier survey, delivery space observation, driver survey, establishment survey	Bordeaux, Dijon, Marseille (1997), Toronto (2006-2007), Breda (2008)	[15], [36], [38], [43], [64]
Vehicle capacity (weight and volume)	Carrier survey, driver survey, observations		[12], [38], [43], [44]
Vehicle crew size	Carrier survey, driver survey, establishment survey, service provider survey, supplier survey	Lisbon (2015)	[38]
Vehicle length	Traffic counts		[38], [44]
Vehicle movements	Carrier survey, establishment survey, service provider survey, supplier survey, traffic counts	Toronto (2006-2007)	[12], [37], [38], [43], [56], [64]
Vehicle speed	GNSS data collection, traffic counts		[37], [38], [64]
Vehicle type	Carrier survey, delivery space observation, driver survey, establishment survey, license plate matching, parking survey, traffic counts, roadside interview, roadside postcard survey, traffic counts, urban goods movement survey, vehicle observation	Antwerp (1995), Bordeaux, Dijon, Marseille (1997), Amsterdam, Groningen, Tilburg (1999), Budapest (1999), Copenhagen (2002-2004), Liège (2004), London (2002 & 2004), Breda (2008), Barcelona (2010), Milan (2010)	[12], [35]–[37], [40]–[42], [44], [50], [53]–[56]
Weight of vehicle and freight	GNSS data collection, license plate matching, roadside postcard survey, urban goods movement survey	Bordeaux, Dijon, Marseille (1997), Rome (2005-2006)	[38], [44], [55], [66], [51]
Externalities			

Indicator	Method	Example	Source
Accidents	Government (police) databases		[12], [35], [67]
Air pollution	Carrier survey, sensors	Bordeaux (1995), Bordeaux, Dijon, Marseille (2000)	[9], [12], [35], [37]
Environmental impact	Establishment survey, GNSS data collection	Lyon (1999), Rome (2005-2006), Barcelona (2010)	[35], [37], [51], [54]
Nuisance to the environment	GNSS data collection, vehicle diary	Bordeaux, Marseille, Dijon (1995-1997), Florence (1998), Amsterdam, Utrecht (2002), Rotterdam (2003)	[12], [35], [43]

Source: Own composition based on [68]

Multiple indicators are developed through different studies. Allen & Browne [49] made in their research a sub-division on the basis of the specific aspects of urban freight distribution that have to be investigated. An overview of those aspects is provided in Table 3.

Dablanc [15] discusses the Freight Urban Mobil Equipment (FUME) indicator, on which no official research has been published. This indicator is a measure of the number of freight vehicles per 1,000 residents in a city. Research shows that FUME decreases when cities become larger. More detailed information on this indicator, its core aspects and key sub-indicators can be found in Table 3 [69].

Table 3 Indicators according to the specific aspect of urban freight distribution

Aspect of urban freight transport	Indicator	Methods
Vehicle delivery/collection trips at establishments in the urban area	Type of establishment, size of establishment, employees at establishment, number of deliveries/collections, delivery/collection frequency, size/type of delivery/collection, number of waste collections, time of day, variation by day of week, variation during year, type/size of vehicle, whether vehicles deliver and collect jointly, type of vehicle operator (own account, logistic company, parcels carrier, etc.), whether vehicles based at establishment, vehicle types/sizes, deliveries/home deliveries made by vehicles at establishment	Establishment survey, vehicle observation
Goods flows to/from establishments in the urban area	Type of establishment, size of establishment, employees at establishment, type and quantity of goods delivered/collected, frequency of goods flow, time of day, variation by day of week, variation during year	Establishment survey, urban goods movement survey, supplier survey
Service trips to establishments in the urban area	Type and number of service trips received, time of day, variation by day of week, variation during year, type/size of vehicle, time taken to carry out service	Establishment survey, vehicle observation
Trip details and patterns of goods/service vehicles in the urban area	Type of operator, vehicle type, vehicle weight, type of goods carried and delivered/collected, type of establishments/land use served, type of vehicle round (singe/multi-drop; deliveries/collections), number of stops per round, number of rounds per day, distance between stops, journey time, vehicle speed, driving time: stationary time, journey length, vehicle crew size, vehicle load factor, empty running, vehicle time utilization, start and finish time, origin and destination/s, type and quantity of goods/equipment carried, fuel consumption	Shipper survey, driver survey, roadside interview, vehicle (trip) diary, GNSS data collection, supplier survey, service provider survey
Loading/unloading activity of goods vehicles in the urban area	Type of vehicle, time of day, parking location (on- & off-street etc.), time taken for service, dwell time of vehicle, number of servicing task by driver without moving vehicle, legal: illegal parking activities, type of contravention during parking	Establishment survey, shipper survey, driver survey, vehicle observation, parking survey, vehicle (trip) diary, GNSS data collection, supplier survey
Parking activity of service vehicles in the urban area	Type of vehicle, time of day, parking location (on-& off-street etc.), time taken for service, dwell time of vehicle, number of servicing task by driver without moving vehicle, legal: illegal parking activities, type of contravention during parking	Vehicle observation, parking survey, vehicle (trip) diary, GNSS data collection, service provider survey

Movement of goods between vehicles and establishments in the urban area	Method of goods handling from vehicle to establishment, type of delivery packaging used, proximity of location to delivery/collection point, quantity of goods, end destination for delivery (shop floor, stock room, etc.), whether staff from establishment need to be present, whether signature is required, whether goods have to be checked by receiver	Establishment survey, shipper survey, driver survey, vehicle observation, vehicle (trip) diary, supplier survey
Origin location of goods flow/vehicle trip to establishments in the urban area	Origin of goods, origin of delivery journey, type/land use of establishment vehicle dispatched from	Establishment survey, shipper survey, driver survey, roadside interview, supplier survey
Ordering and stockholding arrangements at urban premises	Whether stock is held, size of stockholding space, order lead times, ordering system	Establishment survey
Supply chain management between establishments, their suppliers and freight transport operators	Type of supply chain, number of dispatch points to establishment, whether delivery/ collection is regular or ad hoc, who organizes delivery/ collection time, who resolves delivery/ collection issues	Establishment survey

Source: [49]

The BESTUFS project also lists a number of common indicators for urban freight distribution. These indicators and the objectives they serve are displayed in Table 4.

Table 4 Indicators urban freight distribution according to BESTUFS

Objectives	Urban freight indicators	Way of collect	Units in which the indicator is measured
To know the contribution of each industry sector. Make possible a fast appraisal of the generation of deliveries and pick-ups in a town without any survey.	Number of loading/unloading in each activity	Establishment survey	Number of deliveries and pick-ups per employee per time unit
To measure the importance of the goods flows in a zone	Loading/unloading density in a zone	Establishment survey	Number of deliveries and pick-ups per km²
To measure the contribution of each industry sector to the goods flows	Loading/unloading intensity per activity in a zone	Establishment survey	Number of deliveries and pick-ups
To measure the contribution of each industry sector to the road congestion by the on street double parking deliveries	Loading/unloading time in a zone, per vehicle, per activity	Establishment survey	Number of hours of on street double parking for delivery or pick-up
To measure the contribution of the running vehicles delivering each industry sector to the road congestion	Distance covered for loading/ unloading in a zone, per vehicle, per activity	Establishment + driver survey	Number of kilometres covered for one delivery or pick-up
To measure the impact of the location of the platform delivering goods relating to its market radius	Average length of the first leg from platform to the delivery area	Carrier survey	Kilometres
To measure the contribution of one delivery/pick-up to the urban traffic (per type of involved vehicle)	Average distance travelled per pick-up/ delivery	Driver survey	Kilometres per pick-up or delivery

To measure the contribution of the total industry activity on the traffic	Total distance travelled on roads in urban areas transporting goods by HGV, rigid lorries and LGV (<3.5t) used	Establishment + driver survey	Total vehicle kilometres
To measure the time taken for delivering in a tour, on a street, for an industry activity, etc.	Average time taken per delivery (per activity type, per vehicle, own account, for hire, etc.)	Driver survey	Minutes per delivery
To measure the performance of the round for each way of organization, type of vehicle	Average speed per round (including and excluding stops to make deliveries)	Driver survey	Kilometre per hour
To measure the performance of the rounds for each way of organization, type of vehicle, etc.	Average payload per kilometre per tour, per activity, per type of vehicle	Driver survey	Ton-kilometre
To measure the road occupancy per hour	Number of vehicles involved in deliveries and pick-ups per hour per type per size	Establishment + driver survey	Number of vehicles per hour
To measure the impact of urban goods movement on the energy consumption, local and global nuisance and greenhouse gas	Greenhouse gas and pollution according to the zone, the vehicle, the activity, the management	Establishment + driver survey	Grams pollutant per kilometre, grams CO_2 per kilometre, litres of fuel per kilometre

Source: [9]

The tables in this section shed light on the various types of indicators for which data can be collected, based on the purpose that the indicators should serve, with an indication of the respective methods of data collection. The most distinct objectives are leading to the measurement of other types of indicators such as logistics rules, delivery profile, shop profile, stakeholder profile, transport profile, and externalities. The methods by their very nature may overlap between objectives, although their actual target audience, scope and contents will depend on the specific objective. A large set of sample initiatives is also available, which urban logistics decision makers can use to learn from, provided that their city profile is similar to the one present in the concrete study they align themselves to.

In the next section, the methods to collect the data are summarized, analysed and explained more in depth.

Chapter 4 Data collection methods

4.1 Overview of methods

It is impossible to produce definitive statements on the data needed for urban freight distribution. This requirement depends on the specific situation, the current and future planning and policy framework, existing data collection methods and the availability of existing data. The use of a particular collection method is reliant upon the type of data to be collected and the reasons for collection. Consequently, the suitability of a particular method depends on the specific situation. Before collecting data, the purpose of the data and of the model for which the data are input needs to be clarified. Furthermore, any technical or financial limitations need to be determined. Finally, the observation unit must be defined before collecting the data.

The choice of a particular collection method follows from these preceding steps, and whatever choice is made will incur a cost. A trade-off must be made between the costs of collecting the data and of having non-representative data. Moreover, it is important to use the correct sample size for every single data collection effort. Holguin-Veras & Jaller [11] propose some sample sizes based on analyses of the New York Metropolitan Transportation Council.

Holguin-Veras & Jaller [11] developed a framework (see Table 5) for data collection, where both the indicators for which data need to be collected and the method used are related to the kind of data required, the objective and the intended population. Depending on these variables, a different output of data is expected.

Allen et al. [70] indicate that some important aspects to compare data collection methods are the costs, the difficulties surrounding implementation and execution, the quantity and quality of the data collected and sampling considerations.

Allen et al. [53] make a distinction between four categories of collection methods: general surveys, stakeholder-specific surveys, vehicle-specific surveys and land use-specific surveys. Holguin-Veras & Jaller [11] distinguish among four main categories of data collection methods: establishment-based, tour-based, trip-intercept and vehicle-based methods. Establishment-based data collection means that the data collection takes place at the establishment; tour-based data collection includes collection of data by following a shipment along a route; trip-intercept is a method by which data are collected at a certain point of the trip; vehicle-based data collection is the gathering of data at the vehicle-level. In the present paper, the typology of Holguin-Veras & Jaller [11] is followed.

A well-prepared driver and establishment survey[8] enables the collection of a large number of indicators. Otherwise, tracking of individual shipments provides mainly information about the organisation of the transport chain. The most- discussed methods in literature are traffic counts and establishment, carrier and driver surveys. Delivery space observation, accompanying of drivers, tracking of individual shipments and roadside postcard surveys are methods that have been less the subject of research to date. To sum up, it is clear that a combination of different collection methods is necessary to get a full overview of urban freight distribution.

[8] An urban goods movement survey could be added to this list. However, since that is a combination of a driver survey and an establishment survey, it is not separately mentioned here.

Table 5 Framework of data collection

Data	Objective	Target population	Indicators for which data are to be collected	Data collection method	Output
Freight generation data	Support the development of models to express freight production and consumption as a function of economic characteristics (= freight generation).	Primary: Businesses in freight related sectors. Secondary: Businesses in non-freight related sectors that may need or produce freight in a sporadic fashion.	Company attributes; frequency of deliveries; amount of cargo received; commodities most frequently received/shipped; time of deliveries, among others. *	Computer aided telephone interviews.	A dataset with estimates of number of deliveries, amount of cargo (tons), by commodity type, and company attributes.
Delivery tour data	Development of econometric models to describe the geographic patterns of commodity flows, vehicle-trips, sequences of stops and pickup and delivery actions (= delivery tour).	Private and common carriers in the study area.	Company characteristics; tonnage; commodity types; vehicle-trips; tours and delivery sequence; amounts delivered and picked up; and time of travel. *	Travel diaries complemented with Global Positioning System (GNSS) data loggers.	Dataset containing an expanded sample of tonnage transported, tours, vehicle trips, that could be used to produce origin-destination matrices.
Cordon survey	Obtain travel patterns of internal-external, external-internal, and external-external trips (= within, outside or across the cordon).	Freight traffic entering the study area within the sampling period.	The same characteristics of the internal survey for the external trips.	Roadside interviews or postcard surveys to be mailed back or answered through the internet handed out at toll booths.	Dataset containing an expanded sample of tonnage transported, tours, and vehicle trips, used to produce origin-destination matrices.
Agent spatial distribution	Describe the geographic patterns of location of the various agents involved in the freight system (= spatial agent distribution).	Primary: Businesses in freight related sectors. Secondary: Businesses in non-freight related sectors that may need or produce freight in a sporadic fashion.	Company attributes (e.g., number of employees, sales, industry sector, line of business).	Direct purchase of a sample from data aggregators.	Dataset containing georeferenced locations of establishments involved in freight activity, together with company descriptors.

Large traffic generators	Describe the freight production-consumption patterns, and the corresponding generation of freight trips at LTGs (= freight generation).	Primary: Businesses in freight related sectors. Secondary: Businesses in non-freight related sectors that may need or produce freight in a sporadic fashion.	Company attributes; frequency of deliveries; amount of cargo received; commodities most frequently received/shipped; time of deliveries; among others. *	Large Establishments: CATI based on random sampling of potential participants. Large Buildings: Manual counts and interviews at the receiving stations.	Dataset with estimates of number of deliveries, number of truck-trips produced, amount of cargo (tons), by commodity type, and company attributes.
Special purpose models	Collect data to estimate behavioural models and to support the study of specific policy questions (= special purpose models).	Depends on the specific choice process to be modelled.	Data required include company characteristics and stated preference (SP) and revealed preference (RP).	CATI based on random sampling of potential participants.	Dataset containing company characteristics and the SP/RP data needed for behavioural modelling.

Note: * Some of the data could be purchased from data aggregators (e.g., Dun and Bradstreet, InfoUSA), but may not be as accurate as advertised
Source: [11]

Classic surveys are most often used to collect data. The disadvantage of this method is that surveys offer only limited data while being both time- and cost intensive.

Globally, resulting from the wide research done in preparing this document, four different data collection categories are distinguished among as illustrated in the paragraphs below: concerning the establishment, the vehicle, the tour and the trip-intercept.

ESTABLISHMENT

An **establishment survey** is an often-used method of collecting data from total freight vehicle trips to/from certain establishments or from the type of freight being loaded/unloaded. Between 2000 and 2002, an establishment survey was executed in Canada in combination with a shipper and driver survey. The establishments were contacted three times. First, information was gathered via e-mail and telephone communications concerning employment, the nature of the goods/services, and the willingness to participate in the survey. Next, a formal letter was sent by e-mail or fax, followed by a further telephone conversation. Finally, the data was gathered by the survey itself.

In 1997, an establishment survey was also executed in Bordeaux with 1,500 establishments, together with a driver and a freight operator survey (see Table 2). The combination of these three surveys was called an **urban goods movement survey**. A similar survey was conducted in Marseille (2,000 establishments) and Dijon (1,000 establishments). In all three cases, Computer Assisted Telephone Interviews (CATI) were partially used. The knowledge resulting from these surveys can be transferred without calibration to other cities within France and even Europe. This is bundled in the **FRETURB** model [80]. Other examples are the surveys conducted in Canada between 2000 and 2007 in Edmonton, Calgary and Ontario (Peel-region). These surveys were successful, but an important side note is that the availability of a comprehensive and up-to-date establishment database was available.

More recent examples which follow a similar approach are the establishment surveys conducted in Lisbon [57] and New York [71] in 2015, however both surveys focus on more specific sub-markets and transport characteristics. In light of the establishment survey, a questionnaire concerning the activity of the establishment, vehicle fleet, storage capacity, parking facility, etc. was completed based on interviews with the manager of the establishment. Further, the logistics manager also kept a logbook with information concerning loading/unloading operations such as location, vehicle type and delivery time, as well as the name of the freight operator, loading/unloading frequencies and product data. The latter includes product type, package type, weight, origin and destination.

A **carrier survey** can also be conducted. This type of survey provides information on the activity patterns of the vehicles of a company in an urban environment, which facilitates the collection of data from the entire fleet [49]. This method is, for example, applied in the research in Bordeaux in 1997 using face-to-face interviews (see Table 2). The gathered data includes the activity of the company (express, (inter)national, fleet, amount of employment), the organisation of the transport chain, delivery frequency, vehicle fleet related to the urban deliveries, number of vehicle movements, number of loading/unloading operations, daily trips, terminal location, etc.

In a **supplier survey**, the focus of data collection lies with the goods the suppliers deliver to urban establishments and the corresponding vehicle activity. This method is often conducted in combination with an establishment survey (see the first paragraph under this 'establishment' section). If the supplier also takes care of the deliveries, this survey is similar to the carrier survey. The **service provider survey** is also similar to the carrier survey. This method provides data on the pattern of service activities and vehicle activity in the urban area, facilitating the data collection of the entire fleet instead of a single vehicle [49]. In Italy, a retail survey was conducted in the Calabria and Palermo regions. The collected data included the choice of distribution channel, purchase zones, vehicle times, location and size of shop, most important type of vehicles, number of employees, average number of customers per day, storage capacity, etc.

Driver surveys are used to gain understanding of the driving patterns of a truck, the loading/unloading operations, the time required to perform the task, the loading and parking locations, the manner in which the goods are removed from the vehicle, the vehicle type, the vehicle capacity, the activities carried out at every stop, etc. The driver survey in Bordeaux collected data on the amount of stops in the city, the vehicle type and weight, the type of treatment material, the driven distance and the type of establishment.

Parking surveys are similar to vehicle observation, but are specifically used to collect data on the loading/unloading/parking activity of a vehicle. This method can be used to research the use of space originally assigned to freight or service vehicles but being used by other road users [49].

VEHICLE

Using the **logbook** of a vehicle, detailed information concerning its activities over one or several days can be collected. More specifically, based on this information, the exact locations of the truck can be determined, as well as route details, arrival and departure times, the time required for loading/unloading and the type of goods [43], [49]. In France, the Service National de l'Observation et des Statistiques (SOeS) conducts an annual survey of the items mentioned in this section. The results can be used to estimate the performance of heavy vehicles, the amount and type of goods and the number of vehicles. Periodic surveys are also carried out for light vehicles.

Surveys are often complemented with traffic counts or **GNSS data collection** [43]. GNSS data collection is a method by which data is collected automatically. There are three possible objectives. The first is to use GNSS data collection to provide information on new technologies in vehicles or to follow vehicles and in this way capture vehicle information. This can only be done where there are both a limited number of vehicles and a limited amount of data to be collected, since otherwise too much costly data space and processing capacity would be required. Secondly, data can be collected this way to test a model. The advantage here is that the number of vehicles can be reduced and the data is easy to analyse. The third objective uses this method to present the movement of urban goods [43]. This method reaches its maximum value when used to complement other methods.

The disadvantage of GNSS data collection is that it does not provide a general overview of the freight flows and operations [11], [43] and is not necessarily representative of the region [11]. Additionally, since there is a continuous data stream, it is difficult to indicate the end of a trip. Also at the beginning of the trip certain issues arise, since it takes time to locate satellites, and data is not captured during this period. Moreover, both carriers and drivers can perceive the use of GNSS as a breach of their privacy, and the technology still has to be developed further [43].

This method has not been used often for freight transport and therefore there are not many studies [43]. On the other hand, Holguin-Veras and Jaller [11] do indicate the increasing use of GNSS data, as more companies are using GNSS devices. In 2006, data was collected in Melbourne as part of an update of freight data in the region, using a GNSS in 30 commercial trucks delivering office supplies, paper, restaurant foods, quarry materials, and general freight [63]. In 2006-2007, data was collected from 600 shippers and drivers in Toronto. For this purpose, surveys were sent using e-mail, and GNSS data was used. The objective of this survey was to collect specific data concerning shipments, trips and to describe behavioural and economic processes related to commercial vehicles. The GNSS provided data of the driven routes, the location of stops, rest times, fuel consumption, etc. [64]. In 2010, data was collected in Bilbao and Lyon via smartphones in the framework of the European project **FREILOT** (Urban Freight Energy Efficiency Pilot) [81]. The smartphone collected the GNSS location of the vehicle every two seconds, for three different types of carriers: catering logistics, food distribution and express carriers. This project showed that the cost for this type of data collection was around €400 per truck per year [43]. In Vienna data was also collected using GNSS, where the GNSS devices of the drivers of companies delivering in the city were used. It is important to mention here the existence of C-ITS (Cooperative Intelligent Transport Systems). Two freight-related projects within this field are CO-GISTICS[9] and COMPASS 4D[10].

Furthermore, vehicles can be observed in order to obtain data. This method involves estimators in the street close to establishments collecting data regarding the total number of freight trips to and from the establishment per moment of time. In addition, information can be collected concerning the vehicle types used, time taken to load/unload/offer services, methods used to transport goods from the vehicle to the establishment, etc. If more than one entrance is used to load/unload, this method is harder to use. Deliveries/pickups outside normal working hours will also not be captured by the estimator as he/she will not be present. Furthermore, it is not always easy to see which establishment is supplied if the driver does not move his vehicle between different deliveries. The advantage of this method is that it can deliver higher quality information regarding vehicle activity on the street compared to an establishment survey [49].

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[9] CO-GISTICS is a European project working on cooperative services of trucks and vans in several European logistics hubs, including Arad (RO), Bordeaux (F), Bilbao (ES), Frankfurt (DE), Thessaloniki (EL), Trieste (IT) and Vigo (ES) [76].

[10] COMPASS 4D is another European project that ended in December 2015 and was elaborated on in the cities of Bordeaux (F), Copenhagen (DK), Helmond (NL), Newcastle (UK), Thessaloniki (EL), Verona (IT) and Vigo (ES). The topic of this project was the implementation of roadside units on more than 600 vehicles in order to prove the advantage of cooperative systems for citizens [77].

TRIP-INTERCEPT

Interviews can also be conducted with drivers along the route. Here the drivers are asked questions concerning the starting point, destination, the reason for the trip, etc. The objective is to collect information about the number of stops, the location of the stops, their purpose, etc. The disadvantage of this method is that internal traffic within a certain area is not captured [14]. In Canada, a national survey was conducted in 1999-2000 in which drivers were interviewed along the road. Approximately 65,000 drivers were questioned at 238 different locations. This survey was updated in 2006-2007. The objective of this survey was to collect data on transport between cities. In Belgium, this method has already been applied. In collaboration with students from higher education, drivers were questioned in the ports of Antwerp, Ghent and Zeebruges. These projects showed that the method is not easy and that information between businesses could only be compared to a limited extent.

Traffic counts can be executed at street level, neighbourhood level or at the level of an urban area [49]. They can be executed with Automated Vehicle Classifier techniques, such as, for example, Weigh-In-Motion[11], magnetic loops[12] or video cameras [11]. Various countries use magnetic loops, because traffic can be easily counted at a low cost. Moreover, heavy vehicles can be distinguished from light vehicles. This method is particularly useful to monitor and predict traffic [14]. The disadvantage is that the loops should be built into the pavement. This implementation enables functioning in all weather conditions and use of the loops for long-term counts. Weigh-In-Motion techniques are expensive and can only be used on a limited number of locations [11]. The high price of traffic count techniques, such as sensors, is an important consideration when collecting data. One sensor to collect data on the vehicle type costs around €150. In order to track vehicles at different locations, a large number of sensors (in fact APNR cameras) is needed. Altogether, this is a huge investment for which the costs of collecting the data and the benefits of having them have to be balanced.

Pneumatic counting loops[13] can also be used for traffic counts. The advantage of this method is that the counting loops are easy to move, and just need to be placed on the road to be able to count traffic. The disadvantage is the reduction in accuracy when multiple vehicles drive over the counting loop simultaneously. This is often the case on roads with high volumes and high capacity utilisation [11].

Another method is the manual counting of traffic. This requires trained staff who observe and count traffic. Video cameras can also be used. The advantage of the latter is that images can be paused and viewed again [11].

Depending on the objective of the data collection, traffic counts can provide insufficient information. This is because there is a lack of insight into [49]: the freight and service streams supporting the vehicle activity, the specific objective of the trip, the establishments generating the demand for the trip and their requirements, the decisions made in the supply chain resulting in trips at specific moments with specific vehicles, the routes chosen by the vehicles, the type of driving pattern, and details about loading/unloading, parking activities, etc.

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[11] Weigh-in-Motion technique means that vehicle are weighed by passing a certain sensor in the road [78].
[12] Loop built in the pavement to collect data on the vehicles passing.
[13] Pneumatic counting loops are sensors that send air pressure along a rubber tube when a vehicle is passing. The air pressure produces an electrical signal, which is then transmitted to analysis software [79].

An example of a survey to create a profile of the supply for a city can be found in research for the city of Breda [36]. Based on the counts, an overview was made of the supply of shops in the inner city. The main indicators here were the number of deliveries, the volume, the type of delivery vehicle, the type of transport, the time of goods received, the nature of loading/unloading, return and waste streams, storage/conversion plans and the routing.
In addition to this delivery profile, shop owner and driver surveys were conducted to integrate the observations of these stakeholders into the study. Information was collected concerning their views on accessibility for the delivery traffic, strengths and weaknesses, and areas of improvement for delivery in the city [36].

TOUR

Alongside the above-mentioned methods, individual shipments can also be followed along the route, or data collectors can ride with the drivers.

4.2 Stakeholder roles in data collection approaches

To create an overview of the needs and desires of the key **stakeholders** and thus execute a stakeholders analysis, Dablanc [15] proposes the establishment of a permanent urban freight forum, bringing together target audiences on a regular basis. Here it is important to involve all key stakeholders. These meetings can be used to share information, and also to negotiate specific local policies. Alongside this, a freight portal serving as a communication channel between different stakeholders should be set up. In 2010 a freight forum was created in London, at which 120-150 decision makers with respect to receiving and delivering goods in London meet twice a year to discuss key topics [72]. In 2016, Transport for Greater Manchester also opened a freight forum, at which public and private stakeholders discuss logistics issues [73].

Stathopoulos, Valeri & Marcucci [18] collected data on bottlenecks in urban distribution using in-depth focus groups within the framework of their research of the limited traffic zone in Rome. In these focus groups, stakeholders in three main categories were present: freight forwarders, local policy makers and retailers. They found that different stakeholders often have conflicting objectives. A carrier survey was conducted in addition to a consultation with the stakeholders. The objective was to evaluate reactions to the policy by using focus groups.

Browne et al. [8] provide a typology of data collection methods in their research, including very specific methods that are not included in Table 3. The main reason is that these categories are very specific and therefore can be classified under the broader categories of Table 3. Furthermore, in this study, in which countries’ data is collected per data category, the authors indicate if the data is collected at national, regional or urban level, and whether this is collected by businesses or other commercial organisations.

It is important to remark here that privacy issues limit the opportunities of certain data collection methods. Some data collected by authorities cannot be shared with other stakeholders due to strict privacy regulations. Some data are even not allowed to be collected. The latter is the case for tracking the individual trips of vehicles or persons in a number of countries. Furthermore, data are often collected by private companies, who may not want to share their collected data. It is therefore important to establish agreements or partnerships for data sharing. To achieve this, the mindset of different stakeholders has to change and a business model leading to a win-win situation has to be developed. As long as the private stakeholders collecting the data do not have anything to gain, they will not be willing to share their collected data.

Chapter 5 Recommendations

This report has focused on data collection in urban freight distribution. It has determined the common specific indicators needed in an urban freight context (Chapter 3) and the common data collection methods used to obtain these indicators (Chapter 4).

Recommendation 1: *Increase of awareness of the need for urban freight data*

Firstly, there is, in most countries, a lack of publicly available data on urban logistics.. It is therefore important that local authorities are aware of the need for data, of the need for having data collected under the co-ordination of a local authority, and of the use that can be made of such data, with suitable analysis. Freight transport in general is neglected in most studies, and more specifically concerning urban freight. Only a limited amount of data is publicly available. Where data are collected, they often cannot be compared due to different data collection methodologies. Furthermore, they are often not analysed because this is too expensive or because the existence of the data is unknown.

Recommendation 2: *Choose key indicators*

Secondly, local authorities should be aware that different urban indicators are important, depending on what one wants to measure. Consequently, no unambiguous overview can be provided on the specific urban indicators that need to be collected in general. This report provides common indicators used to describe the shop profile, delivery profile, transport profile, analysis of logistics rules, stakeholder analysis and externalities.

Recommendation 3: *Research sound data collection methodologies*

Thirdly, local authority representatives should also keep in mind that different data collection methods exist, and are necessary to collect different data in different situations. The four most important categories of collection methods are establishment-based, vehicle-based, trip-intercept-based and tour-based methods. Each method has its own advantages and disadvantages, and is therefore suitable for certain specific situations (Table 7).

Table 7 Data collection methods: advantages and disadvantages

Method	Advantages	Disadvantages
ESTABLISHMENT		
Establishment survey	- Relatively well feasible to map all establishments and survey them. - Total sample can be relatively easily calculated.	- These are the beginning or end points of delivery chains, not the ones doing the transportation, and therefore not the ones making the actual transport choices. - Hard to check information correctness.
Carrier survey	- Carriers are the ones doing the actual transport, and therefore the ones deciding about the transport choice.	- Carriers are more difficult to map, and especially to survey, since they are mobile by definition. - Harder to determine the total sample. - Hard to check information correctness.
Supplier survey	- Basically the one requesting the transport activity, so partly a decision maker.	- Harder to identify: who is the real sender of the goods. - Hard to check information

		correctness.
Driver survey	- Drivers execute the transportation itself, so they are well aware about the actual flow of goods and traffic.	- Drivers have no direct incentive to participate. - Drivers are not aware of the strategies behind the transport choice. - Hard to check information correctness.
Urban goods movement survey	- More encompassing: groups data and insights from different parties.	- Hard to know how representative the collected information is. - Hard to judge who is right in case sources contradict each other. - Hard to check information correctness.
Parking survey	- Well feasible technique, since when parked, vehicles and drivers can be approached. - Parking issues are an important source of traffic disturbance.	- Parking is only one element of possible traffic issues: no insight in the traffic flow. - Sample may be biased: quite some urban freight transport does use private parking areas, which therefore are much harder to approach. - Hard to check information correctness.
VEHICLE		
Logbook	- Fairly consistent data collection - Well-controlled sample.	- Rather demanding on behalf of the one who has to complete the logbooks.
GNSS	- More or less consistent data collection, without bias to reality. - Uniform technology, which eases data processing and comparability	- Not necessarily representative, let alone exhaustive. - Beginning and end of trip not known - Privacy - Technical issues with satellites.
TRIP-INTERCEPT		
Interviews	- Less demanding than completing a survey.	- Higher risk of bias, voluntarily or involuntarily. -
Traffic counts	- Consistent and correct data collection.	- Partial information: one spot, one moment of time. - Rather expensive. - Privacy issues.
Pneumatic counting loops	- Consistent and correct data collection.	- Needs to be built in infrastructure. -

TOUR		
Stakeholder analysis	- Better view on total transport activity and traffic flow, especially if sensors on board vehicles are used.	- Hard to compare different trip info, even if all trip details are known.

Recommendation 4: *As a local authority, take an unambiguous role in data collection research*

Table 8 specifies, based on the experiences gained from many cases and projects analysed in sections 2, 3 and 4, which role local authorities can play in each of the collection methods, depending on the urban freight aspect that needs consideration.

Table 8 Local authority role for different data collection methods

Method	Role for local authorities
ESTABLISHMENT	
Establishment survey	- Co-ordinating, funding and/or or executing the survey: ○ All cases: ensure that a representative survey is established; provide establishment contact database or let consultant compose database; support with a formal letter to be sent by e-mail or fax, followed by a new telephone conversation. ○ When co-ordinating: ensure that consultant has exclusive ownership / usage rights to the data. ○ When funding: provide budget to a consultant to undertake data collection and processing; provide establishment contact database or let consultant compose database. ○ When executing: provide staff to undertake data collection and processing.
Carrier survey	Co-ordinating, funding and/or or executing the survey, with same possible sub-division of tasks as with 'establishment survey'. Exception: carriers not known by local public authority, so collection is needed by definition.
Supplier survey	- Co-ordinating, funding and/or or executing the survey with same possible sub-division of tasks as with 'establishment survey'. Exception: suppliers not known by local public authority, so collection is needed by definition.
Driver survey	- Co-ordinating, funding and/or or executing the survey, with same possible sub-division of tasks as with 'establishment survey'. Exception: drivers not known by local public authority, so collection is needed by definition.
Urban goods movement survey	- Combination of establishment, supplier and driver survey - Co-ordinating, funding and/or or executing the survey, with same possible sub-division of tasks as with 'establishment survey'. Exception: suppliers and drivers not known by local public authority, so collection is needed by definition.
Parking survey	- Co-ordinating, funding and/or or executing the survey: ○ All cases: ensure that a representative survey is established. ○ When co-ordinating: ensure that consultant has

	exclusive ownership / usage rights to the data. ○ When funding: provide budget to a consultant to undertake data collection and processing. ○ When executing: provide staff to undertake data collection and processing.
VEHICLE	
Logbook	- Co-ordinating, funding and/or or executing the logbook collection and analysis, with same possible sub-division of tasks as with 'driver survey'.
GNSS	- Co-ordinating, funding and/or or executing the GNSS collection and analysis: ○ All cases: ensure that a representative vehicle sample is established; co-ordinate contacts with GNSS operators; support with a formal letter to be sent by e-mail or fax. ○ When co-ordinating: ensure that consultant has exclusive ownership / usage rights to the data. ○ When funding: provide budget to a consultant to undertake data processing; provide GNSS operator contact database or let consultant compose database. ○ When executing: provide staff to contact GNSS operators and do processing.
TRIP-INTERCEPT	
Interviews	- Co-ordinating, funding and/or or executing the interviews, , with same possible sub-division of tasks as with 'driver survey'.
Traffic counts	- Installing magnetic loops / APNR cameras / Weigh-in-Motion systems - Co-ordinating, funding and/or or executing the traffic count processing ○ When co-ordinating: ensure that consultant has exclusive ownership / usage rights to the data. ○ When funding: provide budget to a consultant to undertake data collection and processing. ○ When executing: provide staff to undertake data collection and processing.
Pneumatic counting loops	- Installing pneumatic loops. - Co-ordinating, funding and/or or executing the loop analysis, with same division as with 'traffic counts'.
TOUR	
Stakeholder analysis	- Co-ordinating, funding and/or or executing the focus groups ○ All cases: ensure that a representative forum is established; provide stakeholder contact database or let consultant compose database; support with a formal letter to be sent by e-mail or fax, followed by a new telephone conversation. ○ When co-ordinating: ensure that consultant has exclusive ownership / usage rights to the data.

	○ When funding: provide budget to a consultant to undertake data collection and processing; provide stakeholder contact database or let consultant compose database. ○ When executing: provide staff to undertake data collection and processing.

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