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# Data collection framework for understanding UFT within city logistics solutions

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**Abstract**

Urban Freight Transport (UFT) is a fundamental component of city life. It involves a vast range of activities resulting from relationships among different actors with conflicting needs and goals. Manufacturers are interested in fast and on-time deliveries, retailers require complete assortment and frequent deliveries, citizens wish to have easy access to goods while not losing their quality of life and City Authorities have to face negative externalities related to UFT (i.e. congestion, air and noise pollution, and safety). Concretely, few cities have a well-developed and comprehensive city logistics strategy because authorities generally focus their attention on passenger transport. When city logistics measures have been conceived and implemented, frequently private requirements have not been considered sufficiently. The European Commission includes the lack of data and understanding of freight flows among the main obstacles to the improvement of operational efficiency and planning process for a sustainable UFT in economic, social and environmental terms. Also, the research community raises the issue of the unavailability or the low quality of data on urban freight and the need to identify effective data collection methods in order to understand processes and actors' behavior and then define appropriate city logistics solutions. The NOVELOG EU project is providing city authorities and practitioners with a new framework aimed at systematizing all data to be collected, directly or indirectly, and to be elaborated in order to understand and represent the different aspects of the UFT sector. In order to achieve a complete knowledge, the framework approaches this sector according to four main thematic pillars: 1) profile of major supply chains served in the urban area under study; 2) mapping of urban freight and service trips activity; 3) organizational and legal framework; 4) procedural and technological methods and innovations. The present paper introduces the framework and the guidance it provides to its target audiences.


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## 1. Introduction

### *1.1 Issues on data availability on urban freight transportation*

Urban freight Transport (UFT) was defined by the MDS Transmodal Ltd (2012) as: "The movement of freight vehicles whose primary purpose is to carry goods into, out of and within urban areas". The growing significance of urban freight transport is related to the population and economic growth in urban areas. As approximately 80% of the Europeans live in urban areas and cities generate 85% of the European GDP (COM(2006) 314), this renders the UFT

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a fundamental component of city life. However, the UFT operations are characterized by a complexity which relies on the vast range of processes together with the interaction between the different actors involved, and by a number of negative environmental and social effects like congestion, air and noise pollution, and safety. The overall objective of the EU policy is to achieve the optimization of the complete door-to-door transport chain by maximizing the economic growth while minimizing the environmental and social impacts (MDS Transmodal Ltd, 2012). However, with the cities' authorities mainly focusing their attention on the passenger transport together with the lack of cooperation between the local authorities and industrial actors of UFT, only few cities have a well-developed and comprehensive urban logistics strategy. Moreover, the lack of information and data availability impedes the understanding of the freight flows and results to inefficient urban operations and short term solutions of the urban freight problems, (COM(2013) 913). The unavailability or low quality of data was one of the subjects of analysis and discussion during the EU-US Transportation Research Symposium dedicated to city logistics research (TRB, 2013) while another point that was raised considered the effectiveness of data collection methods and sources and the need to identify the main drivers of the economic activity, which are even more important for understanding the behavior of the private actors. The lack of awareness on UFT activities can be a serious obstacle to determine their current sustainability and to plan and implement appropriate measures to optimize these activities in economic, social and environmental terms. In most cities, city planning and traffic surveys are based only on passenger transport as the collection of urban freight data can result in a very difficult and if not an impossible task to accomplish. The main reasons lie in the complexity of the nature of urban freight transport which is comprised of numerous activities and involves a large number of actors. More specifically, the factors affecting the collection of UFT related data are:

- The numerous activities (manufacturing, transport services, handling and storage of goods, inventory management, waste and returns and retail) that make it necessary to collect data from a large quantity of economic agents.
- The reluctance of the shippers and transport operators to share information on their operations.
- The lack of understanding by the local authorities regarding what kind of data is needed.
- The large cost for the local authorities of collecting and updating urban freight data.

### *1.2 The need for a data collection framework*

There have been many studies and pilot cases that presented the collection of data in the UFT sector. One of the first and most comprehensive of these studies was made in France and was based on extensive freight data surveys (Patier et al, 1997, 2000). This was followed by several studies which focused their attention on the examination, mapping and analysis either of the city logistics in general or of specific elements or areas of the urban distribution. One such example is J. Holguin-Veras (2006, 2007) who focused on the case of Off-Peak Deliveries in NY. Furthermore, M. Browne (2006) and D. Patier (2008 a) presented best practices in data collection, modelling approaches and application fields for urban commercial transport modes. Customized solutions for sustainable logistics were suggested by H. Quak (2011), while J. Allen (2008) recorded urban freight data collection, survey techniques and methods used at international level. In terms of evaluation, an evaluation framework on city logistics measures was developed by S. Balm (2014), while a Business Model analysis on the evaluation results on urban freight solutions was presented by H. Quak (2014). Other studies aimed to increase the awareness in urban freight problems and the understanding of the city logistics (M. Huschenbeck (2005), N. Dasburg (2009), A. Campagna (2011), C. Ambrosini (2001)). Despite this, the examination of the state-of-art and the indications of the research community show that there is still the need to develop innovative data collection procedures and to improve data synthesis, as none of the examined surveys have addressed all the aspects of data and information that could achieve a high level of understanding and description of the multi-dimensional pillars of the urban freight transport sector. The first important step in achieving a clear understanding of the urban freight distribution and facilitating the data collection process is to formulate a generic innovative structure to provide a logical organisation of data and information required to identify and map all the elements of urban freight distribution: actors involved, goods distributed, routes that are followed, data on the demand and the supply, city structure and legal framework that is applied, policies that could improve UFT in specific areas. Thus, this paper aims to present a brand new data and knowledge collection framework which was developed within NOVELOG, an ongoing European funded project.

## 2. The NOVELOG framework for data collection

### *2.1 The NOVELOG project*

The scope of the NOVELOG project is the enabling of knowledge and understanding of freight distribution and service trips by providing guidance for implementing effective and sustainable policies and measures. This guidance will support the choice of the most optimal and applicable solutions for urban freight and service transport, and will facilitate stakeholder collaboration and the development, field testing and transfer of best governance and business models. The first important stage in achieving this scope is to address the issue of data collection, by building a brand new data and knowledge collection framework that will enable capturing of characteristics of a multidimensional activity such as UFT. The NOVELOG framework represents therefore such a generic innovative structure providing a logical organisation of data and information required to:

- identify the supply chains operating their last mile functions in a specific city area;
- understand involved actors' behavior and needs;
- identify goods and services that are produced and consumed in the specific city area;
- quantify the freight distribution demand and supply;
- map urban freight trips and activities;
- identify the city structure and the legal framework that is applied in city logistics;
- identify policies, measures, methods and techniques able to facilitate and improve UFT in a specific area.

Once all these elements are known in depth, the framework supports their organisation and use in order to have a clear understanding of UFT and to design city logistics solutions for a specific urban area.

### *2.2 Description of the NOVELOG framework*

As depicted in Figure 1, NOVELOG established the framework to approach the UFT sector according to four main thematic pillars:

1. *Profile of major supply chains served in the urban area under study.* This pillar concerns categories of goods, owners of chains, delivery profile, origins/destinations, magnitude of commodities transported, typology of fleets and infrastructure used, stakeholders involved, roles and business agreements related to the supply chains operating their last mile functions in a specific urban area. Usually, supply chains are classified by type of goods distributed in an urban area. Instead, NOVELOG takes the approach adopted by the CITYPORTS and SMILE projects, according to which urban supply chains are defined on the basis of the «operating formal procedure for the service and management of goods». This procedure changes depending not only on the type of goods, but also on the structure of their distribution, which includes the distribution channel (retail chain and brands sector, independent retail sector) and the physical distribution.
2. *Mapping of urban freight and service trips activity*. This pillar covers the understanding of trips produced by vehicles carrying goods within urban areas (delivery trips, collection trips, waste collection, reverse flows, etc.) or related to services (e.g. public utilities, telecommunications, cleaning, maintenance, electrical and plumbing services, etc.). It takes into account models and methodologies used to map such activities.
3. *Organizational and legal framework.* It includes legal framework affecting decision-making, planning, operation and management, established or provisional urban mobility plans, identification of public and private stakeholders (transport companies, receivers, shippers) and pressure communities related to the urban freight management, operation and policy formulation, specification of their role.
4. *Procedural and technological methods and innovations.* This thematic pillar concerns policies, measures, methods and techniques related to facilitating urban freight and service trips, assessing and understanding their performance, highlighting their excellence or gaps.

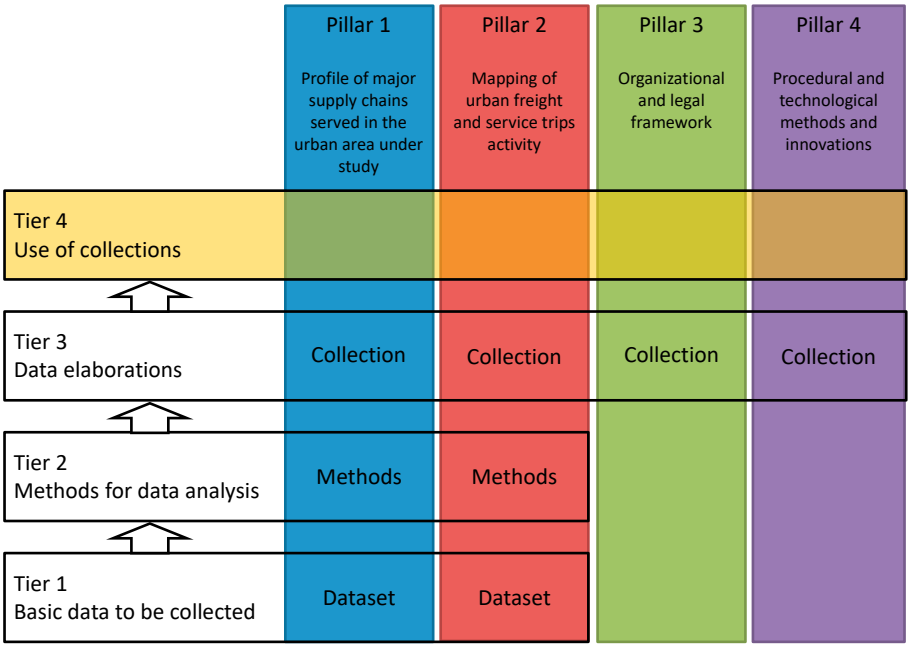


Figure 1. Conceptual layout of the data collection framework (DCF).

According to the layout showed in Figure 1, the framework has also a logical multi-tier structure. In particular, from two to four tiers are needed in order to represent activities on data. In fact, data can be basic (e.g. number of vehicles entering a gate of a LTZ), coming from surveys or existing databases, and can be derived from elaborations on basic data. In this last case we prefer addressing such data as collections (of elaborated data). The logic of the framework is therefore to establish basic data to be collected regarding pillars 1 and 2, individuating then the methods to analyse basic data in order to elaborate collections (e.g. O/D matrix of freight vehicles) on which applications/tools can work to obtain evaluations or to conduct simulations. Basic data (**Tier 1**) are, for example, statistics already elaborated, surveys, interviews, specific databases, and so on. **Tier 2** is intended to describe those methods to be used to analyse the basic data collected in order to produce elaborations. It consists of methods (e.g. techniques, models). For instance, a model to estimate the freight demand belongs to Tier 2 and works on data collected in Tier 1 through surveys on carriers and receivers. **Tier 3** is intended to provide collections of data elaborated by means of the methods in Tier 2 and to be used for further high level analysis and derivations. It consists of databases. **Tier 4** is intended to apply on collections of elaborated data (Tier 3) in order to build up a representation of UFT, to characterize a city, to individuate appropriate measures/policies or to assess a measure/policy, and in general to design a city logistics solutions. It consists of models, methods, and in general tools.

### *2.3 Use of the framework*

With reference to Figure 1, and for what concerns Pillar 1, in order to identify the operating supply chains in a specific urban area, the first step in Tier 1 consists of a census of the so-called “freight demand generators”, namely every activity located in this area which usually orders/receives/ships goods. Since retail services encompass a wide variety of formats (from small shops to hypermarkets) and legal structures (independent stores, franchises, integrated groups, etc.) and the «operating formal procedure for the service and management of goods» used by retail groups is different from that used in the independent retail sector, retail chain stores and independent retail outlets have to be separately recorded during the census. The following step involves an Establishment/Commodity flow survey to be conducted on a statistically significant sample size of independent shopkeepers located in a specific urban area. Participants have to be asked a series of questions about the supplying process of *every type/class of good they*

*commercialize* (type of supplier, type of agreement for delivery, who organises delivery of goods, type of delivery operator, details on delivery process). In addition, participants would also be asked to provide a series of information about their commercial establishments located in the specific urban area. Regarding retail chains, the procedure personally involves them, capturing data about their distribution organizational structure and about deliveries to their stores located in the study area. Higher tier activities (Tier 2 and Tier 3) consist of drawing conclusions about population of activities located in the specific urban area, by means of a statistical inference process. This methodology has been validated in a pedestrian area of the historic centre of Rome and achieved the identification of more than 40 independent retail sector supply chains, characterizing on a quality level 29 of them. Regarding retail chains and brands sector, it allowed identifying, and gain understanding of 25 retail chains and brands distributive behaviors. Pillar 2 covers the knowledge of urban freight transport activities and the understanding of trips produced by vehicles carrying goods in a specific study area. In Tier 1, it is necessary to carry out vehicle traffic counts, disaggregating vehicles by type. This allows to identify the population of vehicles passing through the study area and how this population is composed, in order to carry out further surveys on each subpopulation (stratum). The main purpose is to collect data about trip details and patterns of vehicles belonging to every stratum. Higher tier activities (Tier 2 and Tier 3) consist of drawing conclusions about every stratum by means of a statistical inference process. In any case, this can be merely theoretic since it is not easy to have the actual universe of vehicles used for freight distribution. Consequently, in this case, the inference process may lead to inconsistent results when used for studying city logistics solutions. In addition, the process may be time and effort consuming. Many authors suggest making use of models to understand trips from surveys and traffic counts. In addition, in order to better understand vehicle behaviour, it is possible to use automatic data collection system based on vehicle ICT systems and applications. Pillar 3 concerns collections of data and information related to organizational and legal framework. The latter varies from State to State. Regarding the issue of organizational framework, data to be collected concern the stakeholders' needs. A number of projects and studies performed a stakeholder needs analysis regarding urban freight transport, but related results need to be verified and specified in a specific urban area. Therefore, the first step is to identify and classify all the actors involved in urban freight transport operating in the study area. As described above, the fourth thematic pillar concerns policies, measures, methods and techniques related to facilitating urban freight transport. A data collection on these issues has already been recently carried out as a part of the Urban Freight Transport Study concluded for the European Commission by MDS and CTL (MDS Transmodal Limited 2012). The activity of city logistics best practices dissemination carried out by the European Union by means of projects and initiatives (e.g. BESTUFS, SUGAR BESTFACT, the European ELTIS observatory, the CIVITAS initiative) can be useful to update this data collection. Tier 4 includes the work on data previously collected and elaborated (Tier 1, Tier 2 and Tier 3) in order to design and evaluate city logistics solutions by means of specific tools. This work is to be made through specific applications (tools, models) to be developed. A specific part of the NOVELOG project will be working on this.

### *2.4 Example of application of the framework*

In order to assess the validity of the data collection framework a process to map it on different cities has been conducted. As preliminary results Figure 2 illustrates the mapping of it on the city of Rome, who is working on a pilot project to design and validate a Decision Support System (DSS) for city logistics solutions. After more than 15 years experiences on the sector made of studies and experiments, the Municipality of Rome is, in fact, including a city logistics plan in the SUMP. The DSS to be piloted is expected to contribute to this plan. In accordance with the use of the framework described above, Figure 2 puts in evidence the result of the different actions required by the four tiers process conducted in Rome. As for Pillar 1, basic data (Tier 1) consist of databases coming from three large scale surveys conducted in 1999, 2008 and 2012 on samples of shop owners. Through statistical inference (Tier 2) supply chains have been identified and characterized (Tier 3) and contribute, along with the other Tier 3 elaborations to the work to be done at Tier 4 level. In this case, this work consists of the design and validation of a tool to support the decisions regarding city logistics solutions in Rome (e.g. DSS). In general, the information available at Tier 4 level, is to give a representation of the urban freight transport sector in the specific situation under consideration. As for Pillar 2, during the same surveys mentioned above, Rome conducted traffic counts that made available the dimension and characteristics of freight flows during typical days of a sample week of the year (Tier 1). Through demand-supply

freight transport models (Tier 2) it has been possible, using the results of the traffic counts, to determine volumes (quantity of goods and number of vehicles) and to build on the freight O/D matrix. Also this elaboration contributed to the understanding of urban freight transport and is contribution to the definition of the DSS. As for Pillar 3 and Pillar 4, no basic data are requested. Rome has been able to collect elaborated information (Tier 3) on the regulation (according to the local legal framework) and the planning tools established, along with innovative practices and technologies on ICT or vehicles (e.g. electric vehicles). These information contribute all to Tier 4 activities (represent UFT and design the DSS as for the pilot).

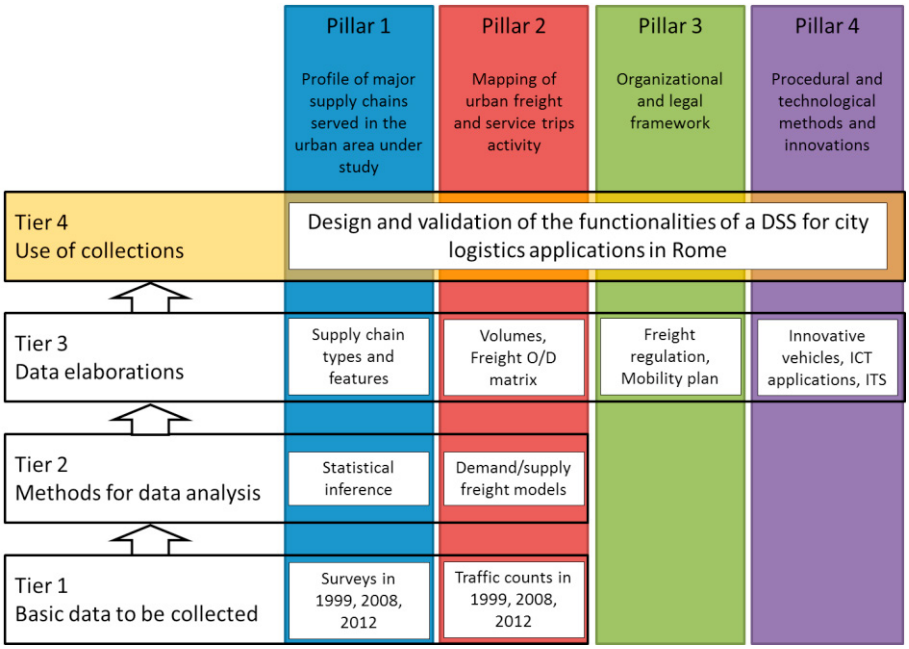


Figure 2. Example of mapping of the framework on the case of Rome.

## 3. Recommendations for data collection in UFT

Research has shown that "significant *improvements are needed in data on urban freight*" and that "*data collection efforts are frequently not comparable*". Most cities do not fully comprehend the UFT characteristics and require guidance on the collection and organization of data and the implementation of measures. A number of research projects have dealt with data collection activities in the field of UFT aiming to identify elements contributing to the understanding of UFT or the organization of data. Each has contributed to the understanding of data collection for certain practices, while some research projects have focused on the survey techniques and methods used for data collection at an international level. To enable the knowledge and understanding of freight distribution, the UFT was broken into four thematic pillars focused on a number of aspects of UFT without overlapping with the others. The understanding of each of the four pillars involves data and information to be collected and elaborated, and they all contribute to the characterization of UFT. The collected knowledge gained from the data of the four pillars will help cities understand its UFT operations and characteristics. This lack of knowledge of the actual problems of a city's UFT is further emphasized by the lack of communication and engagement of the private freight and logistics stakeholders. The framework presented provides city authorities and practitioners with a brand new framework for data, information and knowledge collection, developed to enhance UFT understanding. It represents a generic innovative structure to systematize and organize in a structured manner the data and information required for understanding UFT. The logic beyond the framework relies on the need to have a clear picture on the type of data and the elaborations needed when a process to define a city logistics solution is to be implemented (see Figure 3).

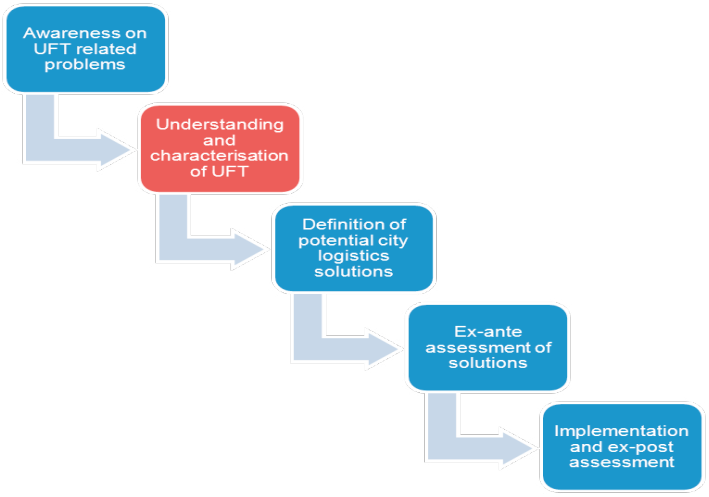


Figure 3. Overall process for defining and implementing city logistics solutions

Therefore, the aim of the framework is to systematize all the data that are needed to be collected, directly or indirectly, and to be elaborated in order to understand and represent the different aspects of the UFT sector and support the selection of appropriate city logistics measures and policies. Recommendations in relation to the use of the new data collection framework are related to each of the four pillars. Therefore, for **Pillar 1 Profile of major supply chains in the urban area under study** the supply chain approach is recommended where the procedure changes depending not only on the type of goods, but also on the structure of their distribution, which includes the distribution channel (retail chain and brands sector, independent retail sector) and the physical distribution. Each city must identify the major supply chains through a census of the so-called "*freight demand generators*" or commercial activities in the area of study. This census will help identify the type of surveys to be implemented to whom in the retail sector to be performed. For **Pillar 2 Mapping of urban freight and service trips activity** the framework requires the data related to the understanding of trips produced by vehicles carrying goods within urban areas or related to services. Data and information available from databases of public bodies should be sought, however often this requires the conduct of surveys and traffic counts. This information can be used to develop an O-D matrix which will feed UFT models and allow the estimation and evaluation of the performance and the impacts of measures and policies on a city. For **Pillar 3 Organizational and legal framework** the measures/policies to be implemented must be coherent with the existing legal, at European, national and local level, and organizational framework. The organizational framework of UFT is complex and heterogeneous, incorporating activities of many actors with conflicting needs and goals. Decisions from the stakeholders are often taken on a commercial and operational basis without consideration of social and environmental factors, while public authorities often implement planning regulations without considering the requirements of the industry. The interaction of all the stakeholders in order to identify their behavior and needs is fundamental to better understanding UFT and implementing appropriate measures/policies. **Pillar 4 Procedural and technological methods and innovations** focuses on policies, measures, techniques and methods related to the facilitation of UFT. These can help complete the understanding of the UFT for a city by providing good practices, lessons learnt and state-of-the-art technologies for facilitating UFT. The collection of information from cities on all the above pillars will assist cities in structuring the data required, the means of collecting it and the methods to elaborate it in order to understand all the aspects of the UFT sector and understand it. The framework does not respond to all the questions of a city in relation to UFT (*what are the problems faced? Who are affected by them? What solutions can be implemented?*), but it aims to help the cities understand what they need to collect in order to get the information which can help them, through the use of elaborations and models, get the answers they need and define sustainable city logistics solutions for implementation.

## 4. Conclusions

The present paper introduces the NOVELOG Data Collection Framework developed according to the need to have a reference structure to logically organize all the data required to have a clear comprehension of the urban freight transport sector in a specific urban area. Such a comprehension is to be used in order to study, develop and assess city logistics solutions. The framework is being validated and used within NOVELOG in pilot cities and cases. Results will be available from the project, expected to be carried on up to 2018.

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