URBAN MOBILITY MANAGEMENT: WHAT ABOUT DISTRIBUTION OF URBAN GOODS?

Rosário Macário
Assistant Professor and Researcher

CESUR, Instituto Superior Técnico, Lisbon Technical University

DIrector

TIS.PT, Consultores em Transportes, Inovação e Sistemas, s.a.

Luis N Filipe
Engineer, MSc. Student and grantholder
CESUR, Instituto Superior Técnico, Lisbon Technical University

Paulo Martins
Engineer
ISEL, Instituto Superior de Engenharia de Lisboa

Vasco Reis
Engineer, PhD. Student and grantholder
CESUR, Instituto Superior Técnico, Lisbon Technical University

Urban Mobility Management: what about distribution of urban goods?

Rosário Macário [1, 3]
rosariomacario@civil.ist.utl.pt

Luis N Filipe [1]
Paulo Martins [2]
Vasco Reis [1]

[1] CESUR, Instituto Superior Técnico, Lisbon Technical University
[2] ISEL, Instituto Superior de Engenharia de Lisboa
[3] TIS.PT, Consultores em Transportes, Inovação e Sistemas, s.a.

Introduction

This paper reports the exploratory results of a recently finished project funded by the Portuguese National Science Foundation[1] and developed at the IST – Lisbon Technical University, designated LOGURB – Optimization of Logistic Systems for Goods Distribution in Urban Settlements[2].

The work undertaken analyses the impacts Urban Logistics have in other urban uses, and proposes a model of distribution on the introduction of a set of new solutions for urban goods distribution. For this, the project will define "Logistic Profiles", which are the logistic characteristics of homogenised groups, defined by the features of territory, and by the specific needs of the goods and the agents. This concept will allow the definition of a conceptual organizational model, which quality will then be evaluated and validated. Based on these analyses, the work provides guidelines for a master plan in Urban Logistics.

The practical approach of this work will be done based on the analysis of the Urban Logistic activity in a specific area inside the city of Lisbon ("Bairro de Alvalade").

Background

In this work, we have adopted the Urban Logistics definition presented by the Urban Freight Logistics Working Group of OECD (OECD, 2003), according to which Urban Logistics is *"the delivery of consumer goods (not only by retail, but also by other sectors such as manufacturing) in city and suburban areas, including the reverse flow of used goods in terms of clean waste."*

From this definition, it is clear that Urban Logistics plays an important role when it comes to urban competitiveness, since it is strictly connected to the economic activities inside a city – we can easily understand that economic transactions are not possible without urban logistics.

However, the distribution of goods within urban settlements has been placing ever increasing constraints to other urban users. This results from a number of reasons,

---

[1] The work on this project is due to finish by the end of March 2007. Therefore, by the time this paper is presented, this information will be outdated.
[2] A preliminary version of this paper was delivered

strictly related to the new trends in urban living, which demand ever faster and cheaper logistic solutions. In the European context, the main driving forces for this increase are (EC, 2002):

- High-profile consumer demands, which lead to flexibility in the production and distribution of goods (faster deliveries and smaller parcels);
- Internationalisation, which leads to the concentration of production and distribution centres in small areas, making it necessary for the products to travel higher distances in order to reach their final destinations;
- Outsourcing of non-core activities, with companies subcontracting specialized partners for some (or all) logistic activities, increasing the efficiency and reducing the costs of distribution;
- Supply chain integration, mainly driven by retailers, who try to maximize their transport and warehousing capacities.
- Information technology advancement, which reinforce the collaboration between agents of the distribution chain, accounting for the appearance of innovative services

The most significant constraints caused by urban logistics are the pollution associated with the transportation, the use of infrastructures built for other needs (roads, parking lots), and the congestion sometimes caused by the space occupied by loading and unloading activities. These constraints place at risk the three pillars of urban sustainability – environmental, economic and social sustainability.

Despite the importance and increasing intensity of these problems in large and medium size cities, local authorities have always denied urban logistics the attention it needs, leaving it to a second plan in what urban and transport planning is concerned. This negligence has a twofold justification: lack of knowledge on the appropriate instruments to solve the problems; and, awareness of the difficulty to achieve stakeholders acceptability to any type of solution that limits their freedom for unlimited use of urban space.

Notwithstanding the problems it causes, urban logistics activities are also victims of a series of problems which affect the other "urban users", namely the congestion on city centres caused by heavy traffic and the lack of urban space for the deployment of its activities.

State of the Art – implemented solutions and modelling in Urban Logistics

Within the complex and problematic background presented above, it is important that some actions are taken, in order to reduce the impacts of the distribution of goods inside cities, yet keeping it in pace with the city needs. In other words, this means rationalizing the distribution process (from the economic, spatial and temporal perspectives), reducing the flow of goods yet keeping the adequate level of distribution to satisfy consumer's needs.

As a way to achieve this, various solutions have been pointed out in several European cities. These solutions are not only aimed at the transport activity, but to the organization of the whole logistic chain. On some cases, the implemented solutions were adopted as "stand alone" solutions, focused on a specific case or problem; on some other examples, combined solutions were applied, i.e., several measures were implemented in a combined form, as part of a broad political strategy for urban logistics.

Generally, the different authors try to group the adopted solutions in accordance to different criteria (Muñuzuri et. al, 2005; Melo, S., 2003; EC et al, 2002). In the scope of this work, the measures identified on the literature review were grouped according to the focus of their application. This systematization is reflected in Table 1, where they are presented according to the degree of intervention needed for their implementation (from "soft" to “hard” measures):

Table 1 – Measures implemented to solve the urban logistics problems

Type of Measure	**Examples**
Legislative and organizational measures	Cooperative logistic systems, encouraging night deliveries, public-private partnerships, intermediate delivery depots.
Access restriction measures	Access restrictions according to vehicle characteristics (weight or volume), conditioning access to pedestrian areas, urban tolls, periodic restrictions.
Territorial management measures	Creation of loading and unloading areas, of load transfers, and mini logistic platforms.
Technological measures	GPS, track and tracing systems, route planning software, intelligent transport systems, adoption of non polluting vehicles and vehicles adapted to urban characteristics (size and propulsion).
Infrastructural measures	Construction of urban distribution centres, and peripheral storing facilities, use of urban rail for freight (freight trams), underground freight solutions.

Some of the measures identified are very ambitious, but others lack the needed coherence and fail to achieve the goals for which they were designed. This happens for a number of reasons, like the relative novelty of the introduction of this subject on the urban management agenda, and also the lack of knowledge about the implementation processes involved in urban logistics and hence on the appropriate way to tackle the collateral problems accruing from these processes. Another very important matter relates with the difficulties associated to modelling of urban logistics. Given its fragmented character, largely caused by the fact that a significant amount of transport is done on private basis, experiences reported across the world that the main difficulty in handling urban logistics lies in understanding the associated origin-destination matrix.

Good planning solutions need good planning tools, i.e. modelling tools capable of “predicting” the evolution of future needs and guide intervention to implement enhancing solutions. However, the state of development in modelling of urban logistics is currently rather poor, particularly when compared to the modelling of urban passenger transport, or even with the freight transport at the interurban level (i.e., regional, national or international levels).

Several aspects may be pointed out as a cause for this sort of *“modelling failure”*, namely the recent nature of the problems associated to the urban logistic activities, the complexity inherent to the urban logistic processes, the lack of insight knowledge on the decision making processes generating mobility needs, the non-existence of base theory, and also the lack of complete and reliable statistical data.

The models developed so far can be grouped into different categories (Russo, F. and Comi, A., 2004): gravitational models, similar to the ones used in the passenger transport, input-output models, and models of spatial equilibrium. The simulation models of transport demand can also be classified in function of the unit of analysis - disaggregated models (focused on the individual actions of each logistic agent) and aggregated models (focused on a group of agents or population). The disaggregate models can be further classified: as behavioural, if they take into consideration only one dimension; as inventory, if they take into consideration multiple dimensions (Hensher, D. et al., 2005). Identically, the aggregate models can be further classified in function of the unit of analysis: based on the products, if calculations are based on the flows of the goods; or based on the vehicles' trips when the focus is the routes and vehicles needed to fulfil the demand on each route. Increasingly, researchers are combining different models in order to compensate the limitations of one with the other (e.g. Garrido et al., 2000).

The development of simulation models allowed, in turn, the development of tools to support the decision process in the logistic activity. The most well known of these tools are:

- FRETURB, developed for the LET (Laboratoire d'Economie des Transports) of Lyon (France), and conceived to analyze and to evaluate scenarios. It calculates the number of vehicles attracted by one given region, in function of its logistic needs, and also allows the computation of the road network and parking lots usage. This tool was applied, among others, to the city of Lyon (Ambrosini, C. et al, 2004).
- WIVER, developed for the IVU Traffic Technologies GAC and PTV GAC. It allows the calculation of the expected traffic (trips generated by different types of economic agents) in an urban area, based on behavioural data. It also allows the segmenting of the traffic generated by type of economic activity and by type of vehicle. It offers great flexibility in the zoning of the urban area, and its results can be differentiated by type of business, type of vehicle and period of the day. From its various practical applications, the ones to the cities of Berlin and Rome in the scope of the European project “REFORM” (European Commission, 1998) may be highlighted;
- VISEVA, developed for the Technische Universität Dresden and PTV GAC, over the previous (WIVER) tool, by adding to it the systems dynamics theory. Besides offering all the functionalities of WIVER, it also calculates the trips, in a disaggregated manner, for origin-destination pairs or alternatively for homogenous groups or even according to the behaviour of the agents. It considers the multiple traffic flows simultaneously and calculates the modal distribution. This tool was applied to several regions, e.g. Chemnitz, Stuttgard, and Freiburg (Lohse D. et al, 2004);
- NATRA, developed for the region of Stockholm (Sweden), based on an extensive survey to the urban logistics on the area;
- GOODTRIP, developed for the Technische Universiteit Delft; it calculates the product flows, the traffic generated by these flows, and the respective impacts. It allows the evaluation of the different phases and stages of the process of urban freight distribution, as well as the evaluation of different scenarios. As output, it gives the travel distance, the load factor in the different logistic chains,

emitted gases and the energy consumed. It was applied to the city of Groningen (Boerkamps, J. and van Binsbergen) with the objective of analyzing the impacts of the different types of urban distribution systems.

Scope and objectives of this work

Departing from the state of the art review presented, and which was carried on the initial stages of the project, it is the goal of this work to find a better overall solution for the Urban Logistics, which shall consider all the agents involved and be made up of different measures. For this, a "3-step approach" methodology was outlined. This methodology is strongly based on empirical data, and therefore an area inside the city of Lisbon was identified according to its logistic needs and urban characteristics.

The first step of the methodology comprises the definition of *"Logistic Profiles"*, which will be explained in detail below. A survey of the logistic activities in the study area was performed, in order to define the Logistic Profiles of a set of the most representative commercial sectors (textiles, restaurants and small shops). That area is embedded in the *Alvalade* neighbourhood which is characterised by having a high diversity of land uses, with residence and services.

The second step encompasses the evaluation of logistic solutions based on different criteria in terms of their suitability for serving the Logistic Profiles. This will allow us to choose the best solution(s) for each Logistic Profile and locate them accordingly.

The third and final step consists in modelling the impacts that will occur if the proposed solution, towards market segmentation, is implemented. This means estimating the aggregate costs and benefits of such implementation.

The methodology synthesized above will allow the definition of a conceptual organizational model for urban logistics, which quality will be evaluated and validated. Based on these analyses, the work will produce guidelines for a master plan in Urban Logistics.

The character of this work is exploratory and aims to demonstrate at a first step that an enlarged study justifies to fully validate the market segmentation approach that is implicitly proposed in the concept of *"Logistic Profiles"*, that follows.

The *"Logistic Profile"* Concept

This concept is based on the hypothesis that in a city it is possible to identify functions with homogenous groups of logistic needs, based on three key variables: the urban characteristics of the area, the requirements of the logistic agents, and the characteristics of the products they transact. The Logistic Profile of a given urban area is thus defined by the interaction of these three key aspects.

In the areas of the city in which it is possible to define a Logistic Profile, it will then be possible to adjust urban logistic services which will optimize the consumption of the involved public and private resources (space, vehicles, etc.), in function of the needs of the different market segments. In brief, the application of the logistic profiles aims at efficiency and effectiveness. Figure 1 provides and illustration of the organisation of the

the urban logistics system. As a departure point the following logistic services are considered:

- Creation of hierarchic freight terminals inside the urban territory, their location and size is to be planned in function of the different Logistic Profiles of the urban micro-zones. These terminals have their own micro distribution networks that can be composed of electric bicycles or similar services ;
- Collective and regular services often using the facilities offered by the regular public transport in its hours of no operation (e.g. light rail transit and underground);
- Services "on demand " (including services "on-call" and "charter" services);
- Self services (e.g. postal cages or safe deposit boxes);
- Cooperative services like car pooling and car sharing

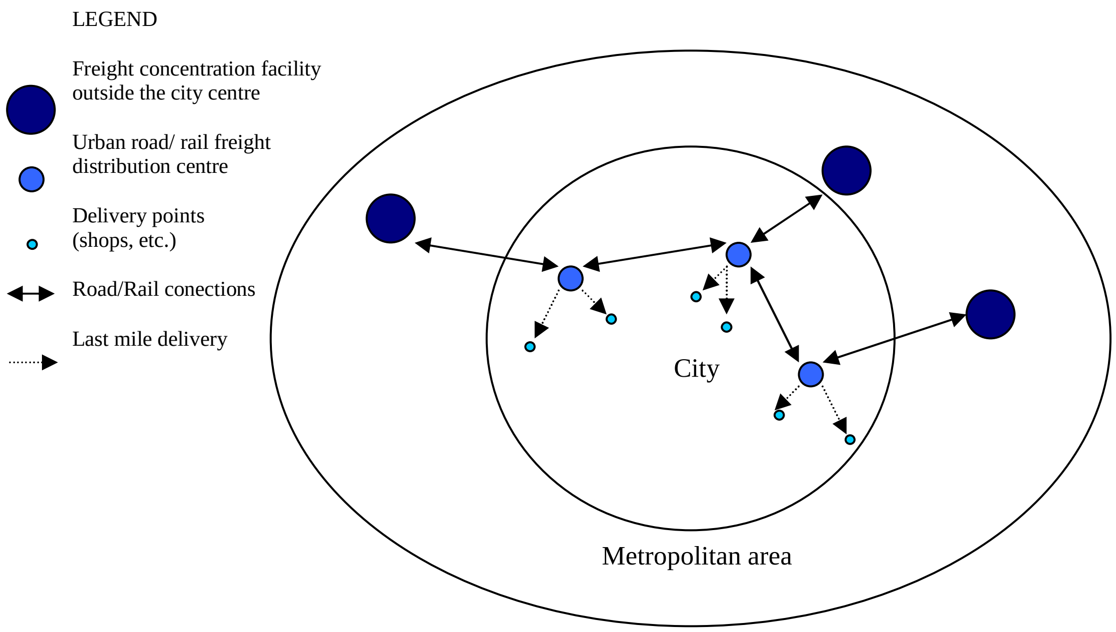

Figure 1: Illustration of the Urban Logistics System

To each of these services a different business model is required but in most cases the possibility of being offered by private initiative seems to be possible, despite the very likely need of a leveraging process that may require public funds.

The outset of the urban logistic system consists in defining and determining the levels of service in the different terminals, as well as its main characteristics in terms of localization, operation and capacity. From the conceptual point of view, this system of logistic distribution is assumed to be a network of services and infrastructures, in which the nodes are the terminals (distribution centres) and the links are the transport services between them. The first and last level nodes are, respectively, the origin and the destination of the goods.

For the definition of the services and services' combinations, it is necessary to consider the specificities of the freight transport inside the urban space, which are:

- Frequency of delivery;
- Load factor of the vehicles;
- Restrictions of hourly and weekly periods of delivery;
- Parking needs for loading and unloading of commodities.

Several other variables are used to qualify the logistic profiles; these are identified bellow:

Table 2 – Variables used to determine the Logistic Profiles

City area features	**Product characteristics**	**Agents needs**
- Commercial density and homogeneity – number of shops per block, and percentage of different shops (in terms of goods sold).	- Fragility.	- Urgency of deliveries.
- Logistic accessibility – level of congestion on the streets serving the area; existence of delivery bays and level access between the shop and the parking of freight transport.	- Perishability.	- Frequency of deliveries.
- Restrictions of hourly and weekly periods of delivery.	- Size.	- Amounts to be delivered.
	- Easiness of Handling .	- Timeliness of deliveries. ("Deliveries beyond opening periods")
	- Special conditions (e.g. Refrigeration needs, etc.).	

These characteristics are largely determined by the specifications associated to each type of good and, consequently, to certain commercial activities. The good performance of the urban logistic system is as much dependent on the service as on the background network since it requires an adequate dimensioning of nodes and links, as a way of optimizing the displacements required to serve the different demand segments, allowing this way the reduction of mobility associated to the satisfaction of urban logistic needs.

The main characteristic of urban logistic system is its high number of stakeholders and the heterogeneity of their needs that forces a very thin segmentation of services often going below the minimum scale for economic feasibility. Consequently for an adequate balance the organization of the urban logistic system should meet the following requirements, which are partially conflicting, as drivers of this optimization process:

- To reduce the direct costs of the agents, both wholesale and retail commerce, as well as of the small industry, or at least do not aggravate their perceived costs (objective of the private agents);
- To reduce the traffic congestion, the environmental impacts and the security risks normally increased by the presence of freight vehicles in the urban road and street network (objectives of the public authorities);

- To increase the quality of urban life through a diversified offer of goods and services which minimize the time spent and global costs (private and public) in supplying families and businesses (objective of the citizens and the local societies).

It is worth stressing that the high costs imposed to a city by the process of urban distribution are identified already for some years. In 1998 the (EC, COST 321, 1998) reported that the freight distribution was responsible for 10 to 15% of the motorized movements inside urban areas, and for 40% of the energy consumption and vehicle emissions; this report also identified that, from all the movements of goods observed in some cities, from 25% to 60% of the movements were inner movements (with an origin and destination inside the city), and the entrance, exit or crossing movements would go from 15% to 30%.

Despite the desirable result being the reduction of the needed motorized movements, it is not only the network optimization that leads to the final solution for urban logistics. It is also necessary to articulate the following areas of intervention, to get consistent guidelines for the creation of an Urban Logistics Master Plan, at the same time allowing the aforementioned requirements:

- Legal and regulation framework for offered services;
- Regulation of motorized vehicles access and temporary urban space occupancy, for loading and unloading activities;
- Road infrastructures with appropriate loading/unloading bays for the activities served by those bays;
- Logistic infrastructures and information systems which support the goods distribution;
- Regulation of security requirements for the transport and handling of goods;
- Incorporation of the needs and specificities of urban logistics in the urban planning activity, joining the environmental and the urban planning sectors;
- Energy policies aimed at the optimization of the urban logistic system fostering the utilization of non-polluting modes in the inner city short-range distribution services that represent a significant part of the urban logistics movements

Matching services with logistic profiles

The concept of the Logistic Profile and its focus on efficiency and effectiveness has a main goal to best fit different delivery solutions to the different needs of each profile. Table 3 provides an example of this matching exercise between the most relevant logistic profiles found with the different delivery services identified.

This table is not meant to be exhaustive but simply to show how this methodology works. It is also worth stressing that slight adjustments in the logistic profiles might result in different levels of appropriateness of the different types. For instance, the solution “Hierarchic Terminals with bicycle or other eco-friendly, light delivery service” turns out unsuitable, for the resulting profile, by simply changing the special needs of the products mentioned on the first profile of the table.

Table 3 – Matching of the Logistic Profiles with the appropriate delivery solution

Logistic Profile Description \ **Delivery Solution**	**Hierarchic Terminals with bicycle or other eco-friendly, light delivery service**	**Cooperative services**	**Safe deposit boxes**
Area profile: Lower commercial density and homogeneity, lower logistic accessibility; any hourly restrictions; Product profile: no special needs nor perishable; Delivery profile: Small amount, frequency and urgency irrelevant	+++++	+	+++++
Area profile: Lower commercial density and homogeneity, lower logistic accessibility; any hourly restrictions; Product profile: no special needs nor perishable; Delivery profile: **Big amounts**, frequency and urgency irrelevant	+++	++	**0**
Area profile: **Higher commercial density**, lower homogeneity, lower logistic accessibility; any hourly restrictions; Product profile: no special needs nor perishable; Delivery profile: Medium/big amounts, frequency and urgency irrelevant	++	++	**0**
Area profile: Higher commercial density and **homogeneity**, lower logistic accessibility; any hourly restrictions; Product profile: no special needs nor perishable; Delivery profile: Medium/big amounts, frequency and urgency irrelevant	++	++++	**0**

Notes:
Highlighted in bold are the main characteristics that change between profiles;
The appropriateness of the services ranges from:
+++++ 'Service highly suited for the profile' to 0 'Service not appropriate for this profile'

The setting for the envisaged model

The neighbourhood chosen as study area for this project is a multifunctional neighbourhood in the city of Lisbon, known as "Bairro de Alvalade". This area, which planning started in the 1930's, is one of the first and most interesting experiences concerning urban planning in the city of Lisbon.

"Bairro de Alvalade" is a central and consolidated residential area, which simultaneously offers many and diversified services. It has very intensive commercial streets, which mix traditional and modern shops, some warehouses and many restaurants and cafés. The clients of these facilities are not only the residents in the neighbourhood, but also the employees who work in the area.

The complexity and diversity found on the commercial tissue of “Bairro de Alvalade” lead us to think that it might be a very demanding area in logistic terms, and also that it must have a number of situations which might be representative of what happens in the whole city. On the other hand, being a planned neighbourhood, it hasn’t the urban complexity found on the older parts of the city (very narrow, steep and winding streets) which could represent additional complexity that is not representative of the whole city.

Figure 2 shows the “Bairro de Alvalade” and its location within the city of Lisbon.

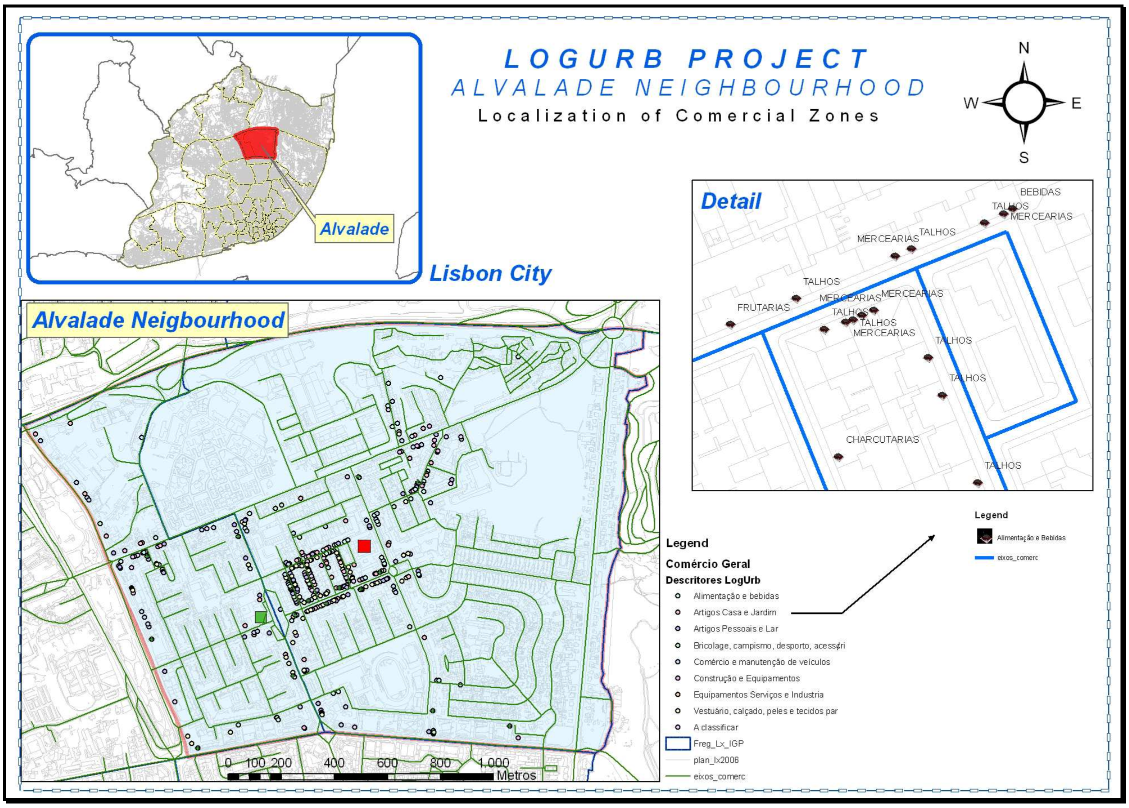

Figure 2: Location of the Study Area (Bairro de Alvalade)

In order to briefly characterize the logistic activity on this neighbourhood, a direct observation survey was done on its main avenue (Avenida da Igreja), in which a majority of the shops is located. This was done by observing, for a whole week, the delivery of goods to three kinds of shops: home textiles, clothing and shoes shops, restaurants & cafes, and markets & small food shops. These clusters of activity were chose again due to its capacity to represent a large part of the logistic movements.

This data was then analysed concerning deliveries per day/time period, per type of product and per type of shop. The graphics on figures 2 to 5 show the main results of these analyses.

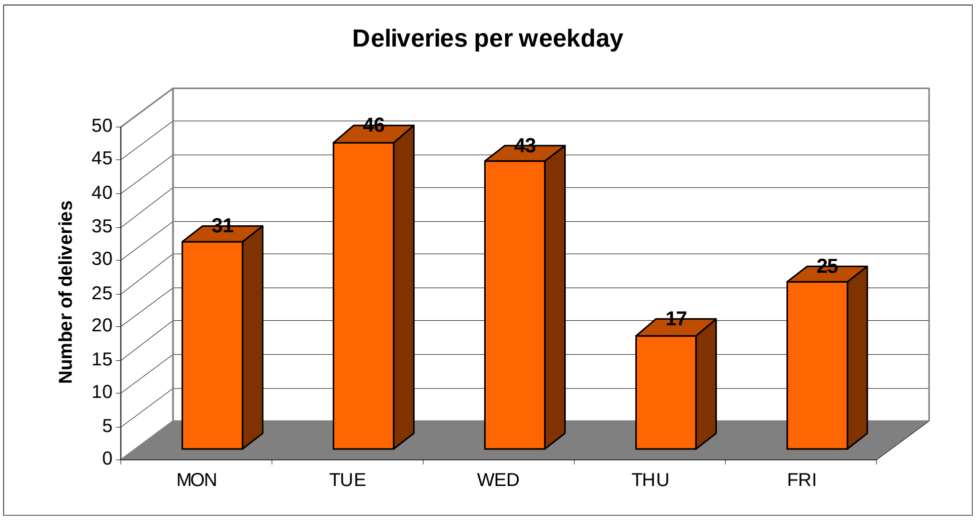

Figure 3: Deliveries per weekday

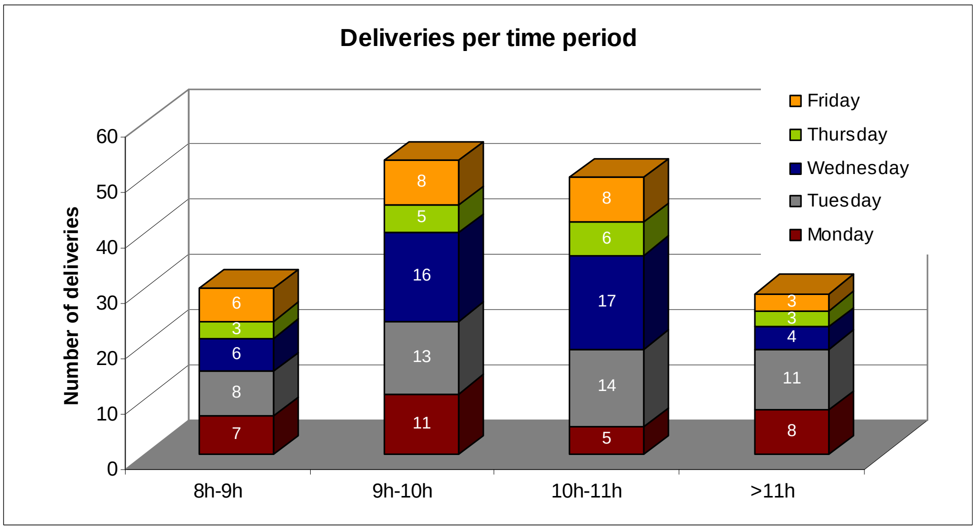

Figure 4: Deliveries per time period

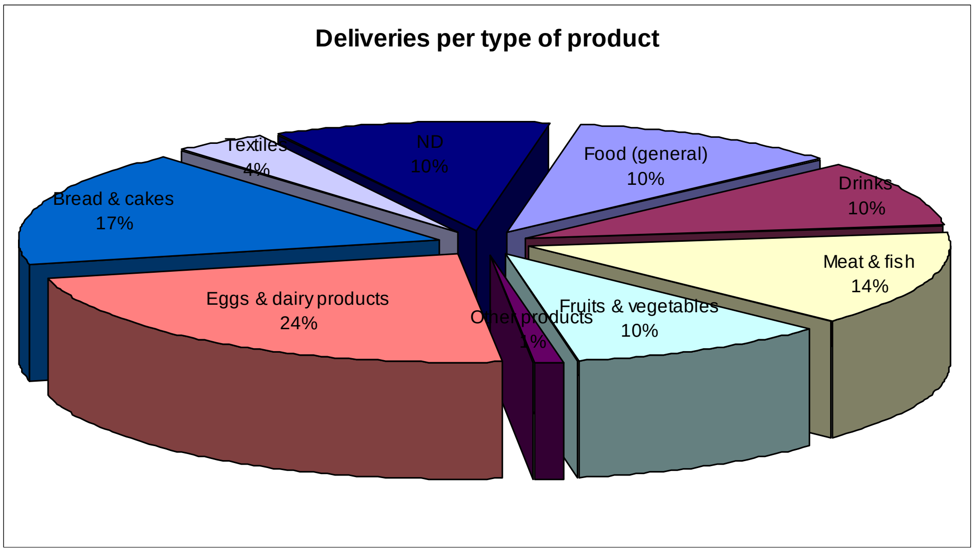

Figure 5: Deliveries per type of product

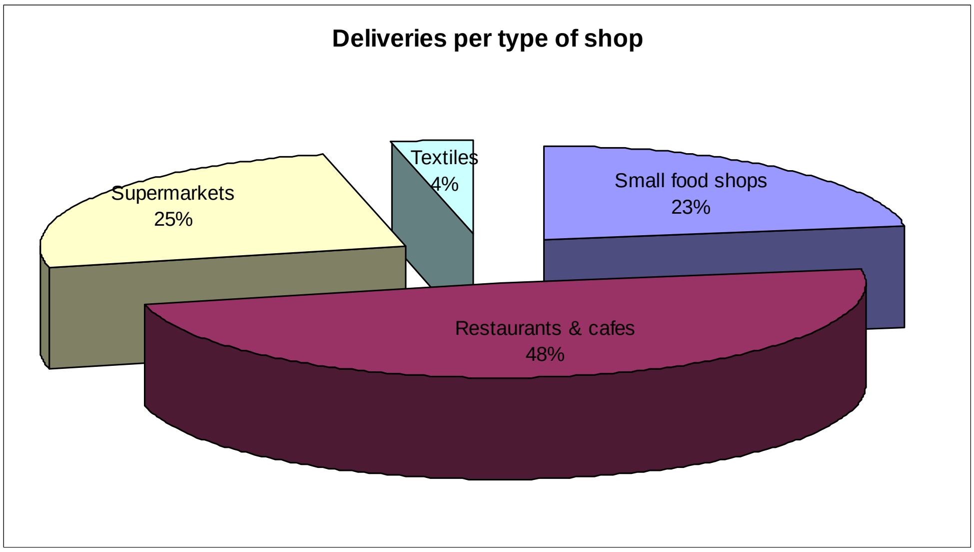

Figure 6: Deliveries per type of shop

One big problem in the whole city of Lisbon is the use of the traffic lanes for loading and unloading activities due to the lack of appropriate bays. This causes congestion, problems to other road users, as it obstructs the normal traffic flows, and even creates difficulties and risks in the loading and unloading tasks. Therefore, the duration and the place in which these tasks were undertaken were also analysed the duration and the place in which these tasks were undertaken. The results are shown on Table 1.

Table 1. Number of deliveries according to the parking of the vehicles

Place of parking during loading and unloading activities	Number	%	Average parking time (seconds)
Parking lot / appropriate delivery places	50	31%	15
Traffic lane	112	69%	12
Total	162	100%	13

The analysis clearly reveals that shops that deal with food, drinks or related products are highly demanding activities in terms of delivery, and seem to be the ones causing the most problems within urban logistics. However it was not possible to distinguish which of the following two factors justifies this position: the type of business, that is small shops and storing facilities, which implies a high rotation of stocks; to the specificities of the products, most of them are perishable products and cannot be stored for long periods. A more detailed survey is needed to understand the contribution of the different attributes of the business to the stress of the urban logistic function.

Concerning the loading and unloading activities, it was confirmed that these pose a major problem to the city traffic flows, since most of them are done using the traffic lanes.

The proposed management model consists in a network of urban terminals and complementary services (which might be used or not with the terminals), each of them focused on a different Logistic Profile. The background rational is that each profile has a best matching service, which will be defined taking into account the profile needs and characteristics (in terms of delivery frequency needs, product specific needs, and so on). The different services will have to be implemented in an integrated way, since they are part of a package which shall not be deployed partially without the risk of loosing its effectiveness. The types of solutions being currently evaluated, which later will be the focus of a more detailed specification, are the following ones:

- Self-servicing deposit freight boxes;
- Electric motorbikes for delivery of small parcels
- Electric trolleys
- On call services
- Regular distribution vans from the terminal
- Car pooling
- Car sharing
- Public transport for freight delivery (tram and underground)

This approach will be tested on the study area (with the exception of the last solution, public transport) for which the location of an urban terminal will be devised and the implementation of the different services evaluated. This valuation will test the new situation against the present one, considering costs and benefits obtained confronting the business as usual scenario with the hypothetical scenario where these services are implemented.

After testing these solutions, it will be possible to enunciate guidelines to be adopted to the whole city, in the form of an Urban Logistics Plan, which should be used as a tool when planning new investments (or changes in the existing ones) that deal with freight delivery inside the city.. By adopting these guidelines incremental improvements are envisaged in the old area and a new approach based on this concepts can be though for the new areas.

Model test and validation

The goal of the modelling carried out on this project is to analyse and measure the potential efficiency gains obtained from implementing the different urban logistic solutions presented above. It is also an essay for the development of modelling procedures using a GIS tool – in this case, the ArcGIS 9.1 with Network Analyst software, from ESRI – which allows the combination of transport modelling and networking with the representation of the city organization.

The modelling work was done over a geographic information library consisting of:

- the main urban roads in the Metropolitan Area of Lisbon, and representing the network of the sub-urban area;
- the complete road and street network for the city, and
- a very detailed network for the study area, with all the details for streets and direction of traffic flows, traffic signs.
- Parking areas and access restrictions, pedestrian and bus networks, and commerce facilities were also modelled as part of the city model. The last elements were very useful to define conflict areas and pressure points in the urban tissue of Bairro de Alvalade.

Despite the object of analysis (Bairro de Alvalade) being just a neighbourhood, it was necessary to consider also, in the model, the interaction of its street network with its network of access (i.e. the roads which give access to its neighbouring areas). A road network efficiency ranking was done for the different solutions (or models), as well as other relational (non-physical) aspects integrated in the management of a logistic chain.

Since the work is being done on a very small scale, the inclusion of other elements of the supply chain (the actors) would be extremely interesting; however, this proved to be very difficult, as the resources used in the survey were limited. On the other hand, modelling the non-physical links and nodes of the logistical chain is very demanding, and therefore some simplifications were made, which however did not jeopardise the main results concerning the social e organizational gains.

In terms of road network efficiency, the results achieved so far are very encouraging, showing high physical network efficiency gains (in the study area as well as within the access paths) accruing from some of the solutions tested in the study area. However, these gains should be confronted with the overall efficiency of the freight distribution model. This means that the economic gains achieved with the road network reorganization must be compared with the losses for some of the actors inside the Logistic Chain – using a private cost approach – and compared with the gains (and eventual losses) for the citizens, namely for the residents and workers and the society as a whole.

The modelling work is currently underway, and by the time it finishes we expect to have a quantification of the net benefits obtained with the implementation of the solutions proposed.

After this brief characterization, and due to the impossibility of undertaken an in-deepth study covering the whole neighbourhood, two of the main commercial blocks where used for a deeper analysis aiming to test the solutions proposed before. These blocks are shown on Figure 7 below.

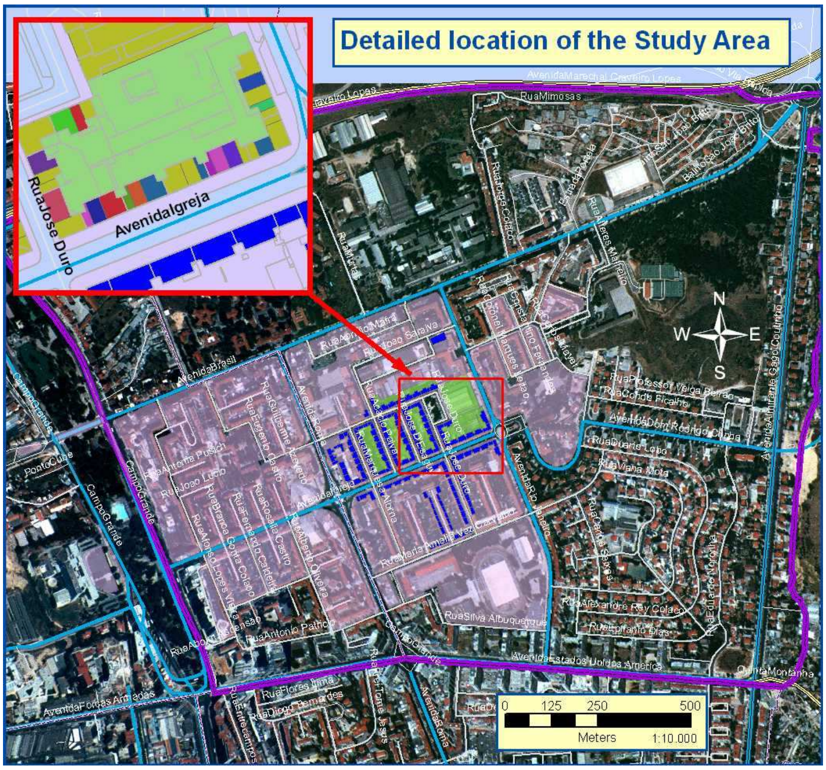

Figure 7 – Location of the streets used for deeper analysis and validation tests.

Case study analysis and preliminary results

The Case Study analysis consists in the development and comparison of two scenarios: BAU-Business as Usual (Scenario 1); and a future organizational model reflecting the application of the “Logistic Profile” LP concept (Scenario 2).

The implementation of both scenarios is based on the development of extensive logistic inventory for two sets of street (Figure 8) from the Alvalade Neighbourhood. A micro-distribution freight model was build over that inventory. This model is directly linked with Lisbon road network and with general metropolitan road network. The inventory allows the implementation of logistic schemes with activities segmented by nature of the goods and by the technological solution implemented for local distribution.

In order to simulate the vast and diverse origins (generation) where goods are coming from into the Alvalade Neighbourhood, the analysis was further segmented into three geographical rings. The first ring is defined by the frontier of the neighbourhood itself and the interior, with the model simulating the local impacts and the changes at microscopic level. The second ring is limited by the city centre and includes Lisbon major inner systems (simplified simulation of distribution and road network). It allows the quantification of impacts from goods entering in Alvalade coming from other neighbourhoods inside Lisboa. The third ring allows the analysis of changes achieved from goods received directly from the outskirt of the metropolitan area of Lisbon.

In what concerns the total number of movements ‘attracted’ by a specific commercial activity, no statistical information has been found in Portugal; which has required the development of a methodology to determine those values. This methodology is depicted in the following figure and is processed as follow.

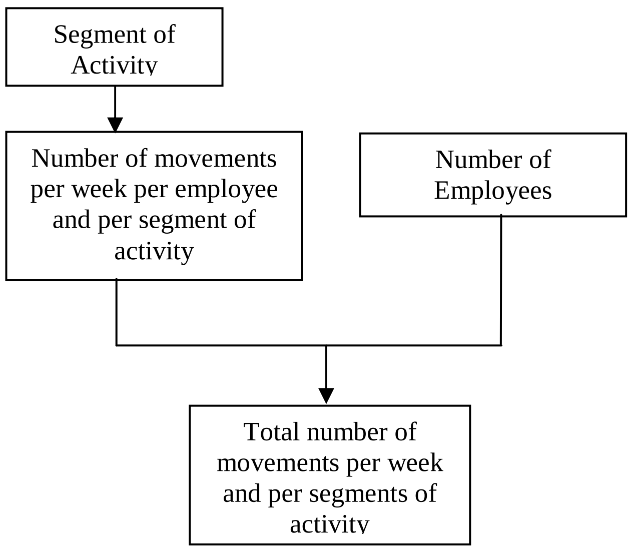

Figure 8 – Methodological workflow for the definition of logistic deliveries

The first step consists in identifying the various types of commerce within the area of study, since each commercial activity generates specific traffic patterns; and secondly the number of employees per store. The employees are a proxy for calculating the amount of movements generated by a certain store. A higher number of employees denotes higher flows and consequently higher movements. Finally, using data from a study conducted by the Laboratoire d’Economie des Transport (LET, 1998) for the city of Paris, which gives for each segment of activity the number of activities per week and per employee, the total number of movements that each store generates can be obtained.

The area under analysis represents twelve segments of commerce. The following table presents those segments, along with the total number of employees and the total number of movements. It is worth mentioning that the parameters given by the LET study do not follow a linear function in respect the total number of employees, instead they show a decreasing behaviour: the higher the number of employees, the smaller the number of movements generated by each one.

Table 2 – Commercial segments of concern for the Case Study

Segment	Total number employees	Total number of movements
Café, Restaurants	30	236,12
Hardware store	5	44,05
Pharmacy	8	260,8
Textile and Shoes	35	118,85
Library	1	12,9
Small market	5	67,5
Market	11	273,9
Butchery	12	117,96
Furniture	5	26,85
Pure services	20	42,43
High flow services	5	34,35
Other retail	27	225,45

So, a total number of 164 employees generate some 1416,16 movements per week. This value was then used to compute the value of the GCF.

In what concerns the scenario situation, it is assumed the total number of movements per segment is equal to the current situation. Thus, the only change concerns the solutions deployed in the logistics distribution. While in the current situation the urban logistic distribution is made based only on road vehicles, in the scenario situation are considered the following solutions, already described in Chapter ?.?: bicycle, postal box and car pooling. Additionally, it was considered two other solutions: alternative fuelled cars and no-change. In both situations, road vehicles are deployed in logistics activities, however, the former one makes used of less pollutant vehicles; while in the latter situation there is no change for the current one.

To keep the scenario as real as possible, it was considered that a significant share of the stores would not change their current logistic solution. Thus, the minimum percentage of movements using road vehicles considered is 50%. The exceptions are the libraries and other retail, where it is expected a higher penetration of the other logistic solutions. In what concerns the former segment, the reasons are, firstly, the majority of the goods not being perishable and, secondly, it would be expected that librarian business people would be more sensitive to sustainability issues and thus more prone to adhere to change. In what concerns the later segments, the reasons are firstly and like the previous segment the majority of the products not being perishable and, secondly, a considerable amount of the retail commerce is nowadays in the hands of large companies that would certainly shift to different logistic solutions if profits could be earned.

Table 3 – Percentage of movements for each logistic solution

	Bycicle	Box	Car pooling	Sustainable Cars	As usual
Café, Restaurants	25	0	0	30	45
Hardware store	20	15	0	20	45
Pharmacy	10	0	0	30	60
Textile and Shoes	30	0	0	25	45
Library	40	10	15	20	15
Small market	20	0	30	15	35
Market	20	0	10	15	55
Butchery	0	0	0	50	50
Furniture	20	10	0	20	50
Pure services	40	0	0	30	30
High flow services	40	0	0	30	30
Other retail	25	10	20	20	25

Applying these parameters to the table of movements, the total amount of movements per segments and per logistic solution is obtained.

Table 4 – Total amount of movements per segments and per logistic solution

Segment	Bycicle	Box	Car pooling	Sustainable Cars	As usual
Café, Restaurants	59,0	0,0	0,0	70,8	106,3
Hardware store	8,8	6,6	0,0	8,8	19,8
Pharmacy	26,1	0,0	0,0	78,2	156,5
Textile and Shoes	35,7	0,0	0,0	29,7	53,5
Library	5,2	1,3	1,9	2,6	1,9
Small market	13,5	0,0	20,3	10,1	23,6
Market	54,8	0,0	27,4	41,1	150,6
Butchery	0,0	0,0	0,0	59,0	59,0
Furniture	5,4	2,7	0,0	5,4	13,4
Pure services	17,0	0,0	0,0	12,7	12,7
High flow services	13,7	0,0	0,0	10,3	10,3
Other retail	56,4	22,5	45,1	45,1	56,4

Results for the First Ring Analysis

The present stage of the Case Study modelling allows the presentation of some interesting preliminary results and the comparison of both scenarios for the first, or local, ring. The results will show only changes related with the improvement of local efficiency, and do not reflect some important gains achieved with the concentration of goods coming from the larger geographic area.

The implementation of Scenario 1 (BAU situation) implies the overall modelling of movements for each commercial unit or service. Figure 10 shows the neighbourhood and a detail about the construction of the local O/D freight matrix, which allows the computation of local mileage and trip time.

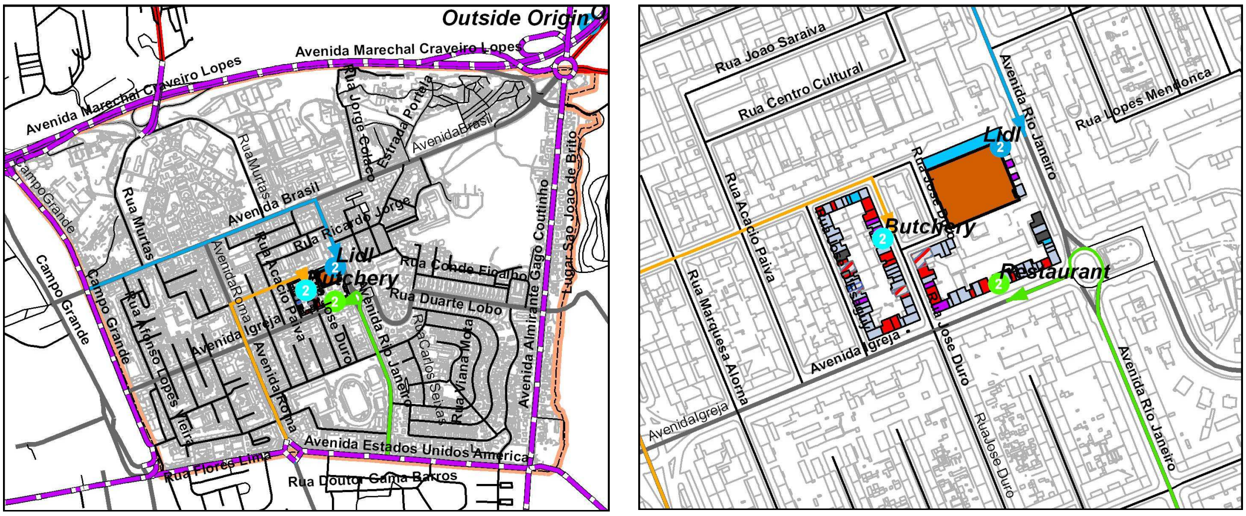

Figure 9 – Operational details from Scenario 1 using the First Ring model

The modelling used ArcGIS 9.2 with the Network Analyst extension and the road network characterization for morning peak period, simulating actual near congested situation.

The two blocks (see right side picture of figure 9) analysed in deep detail contain about one hundred commercial and service functions representing fourteen different market segments from pharmacy to cafés and restaurants, or high flow services. The number of employees is about 240 and the number of weekly freight delivery movements is near 750 for Scenario 1, including the movements from the local traditional market.

The deliveries inside the First Ring represent the consumption of 356 hours of average trucks (with motorist and sometimes assistant) in the Neighbourhood leg of the truck trip and on the activities related with unloading and deliver (these were surveyed by the project team). The total mileage only inside the ring is about 1650 kilometres per week. Rough estimates of annual impact may be done, assuming an annual equivalence factor of 52 (weeks). This implies a total of 18500 truck hours and a mileage of more than 85000 km screening only the First Ring impacts. These represent more than 0,5 million euros for the two blocks and the one hundred urban functions analysed. The extended analyse will show bigger costs and will increase the term related with the mileage which is somehow minimized within the current situation.

The construction of Scenario 2 implies the existence of a Local Terminal for the distribution of goods using the new solutions appointed for delivery. A preliminary location analysis over the consolidated area revealed two candidate places which were further analysed. For reasons related with the availability of space, the local impacts generated by the Terminal (quality of accesses, emerging freight traffic, etc.) and the desired proximity with the candidate area for the construction of the commercial and services inventory, the choice was an area near the Market Place, as signalized on figure 10.

The changes brought with Scenario 2 consist in a two fold and two steps implementation of the freight assignment sub-model. First, the freight trips are divided in two distinct groups: one on which trips will remain unchanged; the other, contains the movements that use the new logistic scheme. The first group will continue running in the first model (prepared for Scenario 1). The second one is going to feed the ‘two steps’ implementation developed for Scenario 2. This may be seen as an inter-modal trip chain, in which the freight mode changes, but with a mode complex situation, because the generation factors does not remain constant: the capacity of the end term delivery mode is of course lower and there is a need for more end trips. The left picture from figure 11 shows the location of the Terminal and the right picture represents the ‘service area’ for the bicycle trips that guarantee part of the deliveries from the Terminal (the colour rings represent 1, 5 and 10 minutes delivery time).

Figure 10 – Scenario 2: location of the Terminal and service area for bicycles.

Results for adoption of Scenario 2 imply a less intensive use of trucks or lorries, a greater occupancy of the freight vehicles delivering in the Terminal, the use of the new local delivery services, using clean vehicles like bicycles, tricycles or cars moving on renewal energy. The counter effect is the need to operate a two stage delivery system, which implies the unloading and logistics in the Terminal as a new time consumption element of the delivery chain.

The results for the First Ring show there is an increase of around 7% (about more 350 truck hours per week) in time used in the delivery chain, but there is a mileage reduction of about 17% (1650 km per week). A first strong conclusion can be taken from these figures: even if there is not an overall economic balance at this First Ring (compensation of labour costs by other diminishing impacts) the local environmental impacts are undoubtedly positive because the mileage reduction of 17% is an important factor for the reduction of air pollution, noise, accidents, and other urban impairments.

It is expected that the results to be achieved on the next runs of the two scenarios, using the second and third rings for Lisbon will invert the operational balance in terms of costs, and that the benefits achieved will overcome the increase in truck operational time cost. In that case the opening path for the economical viability and eventually for the assessment of the whole operational autonomy for the Terminals will be fulfilled.

Conclusions

The main preliminary conclusion to be drawn from this study is that no single solution can be adopted for the urban logistics problem. Different from the logistic of passenger the freight has a much more fragmented demand which requires the concerted offer of different services that should complement each other in satisfying the different requirements of the stakeholders of an urban area. The preliminary results obtained seem to validate the relevance of the departure thesis that a market segmented approach with the mix of services presented herewith should solve the large majority of existing logistic profiles.

One of the barriers to a greater improvement is the fact that some of the deliveries carried out are done by the shopkeepers (who are also the shop owners) using their private cars and no record of these movements is available. It is expected that these elements will not join the solutions pointed out, unless there is some kind of regulation or price mechanism forcing them to do so. Otherwise, the “private” option will remain cheaper and therefore unchangeable.

In addition, some difficulties were found to establish the setting for the proposed management model largely related with the lake of existing information regarding the movement of freight in urban areas. As already referred this is not independent from the fact that a considerable amount of movements is ensured either by private consumers or by semi-private operations, that is the typical self-handling of freight for the small shopkeeper.

Considerable room for innovation has been found in two particular fields of interventions that revealed to be fundamental for the development of a management model for the logistic of urban freight. These are: modelling tools that encompass this fragmented reality; and, a client resource management (CRM) tool to enable and effective network management

Just like urban mobility system in its whole also the sub-sector of urban logistics requires to be planned and monitored against the performance of the system, of the networks and of the services.

Bibliographic References

Ambrosini, C., Routhier, J. and Toilier, F. (2004) How do work urban policies on the urban goods transport flows?, **Proceedings 10th World Conference on Transport Research**, Istanbul, Turkey, 4-8 July 2004.

Boerkamps, J. and van Binsbergen, A. (1999) GoodTrip - A New Approach for Modelling and Evaluation of Urban Goods Distribution, **Proceedings 2nd KFB-Research Conference**, Lund, Sweden, 7-8 June, 1999

EC, 2002. “City Freight – Inter- and Intra- City Freight Distribution Networks – Work Package 1: Final report – Comparative Survey on urban freight, logistics and land use planning systems in Europe”

Lohse, D., Glücker, C., and Teichert, H. (2004). A demand model for urban commercial transport, **Proceedings 2nd International Symposium Networks for Mobility 2004,** Stuttgart, 29 September - 1 October, 2004.

Melo, S. (2003) **Uma Logística Colaborativa para a Cidade (MSc. Thesis),** Departamento de Engenharia Civil da Universidade do Porto, Porto

Muñuzuri, J., Larrañeta, L., Onieve, L. and Cortés, P. (2005). Solutions applicable by local administrations for urban logistics improvement, **Cities**, 22 (1)

OECD (2003) Delivering the Goods - 21st Century Challenges to Urban Goods Transport, OECD Publications, Paris

Russo, F. and Comi, A. (2004) A state of the art on urban distribution at European Scale, **Proceedings 8th Conference on Mobility Management**, Lyon, France, 5 - 7 May, 2004.