A simple logistical management system for limited-access zones for goods vehicles in medium-sized cities

Authors: F. Ballini, R. Bozzo, R. Genova, S. Migliaccio, G. Rinaldi

F. Ballini, Centre of Transport Research, University of Genova, Italy
R. Bozzo, Director of the Department of Electrical Engineering, University of Genoa, Italy
R. Genova, Centre of Transport Research, University of Genova, Italy
S. Migliaccio, Centre of Transport Research, University of Genova, Italy
G. Rinaldi, City Council of La Spezia, Italy

1. Introduction

The municipal planning and management of logistics for goods delivery is certainly more difficult for smaller and medium-size cities, as compared to larger cities, from both an economic standpoint and with regards to available resources. On the other hand, the adverse effects induced by goods vehicles are equally as evident: higher levels of congestion, which often leads to double parking and illegal use of public places for unloading and loading, and higher levels of air and noise pollution.

This paper will study a system currently being considered for the loading and unloading of goods in an urban context in the Italian city of La Spezia.

The solution is based on an information system through which:

1. Carriers can register and acquire a personal parking permit;
2. The carrier can access real-time information on available parking spaces via the web, phone or information panels;
3. A sensor will register the vehicle's arrival in a parking space and will issue the driver with a ticket stating the time of arrival, which must be displayed;
4. The sensor registers the departure of a vehicle from a parking lot and calculates the fee;
5. The fee will be calculated based on a set of variable fees depending on the time of day, the day of the week and the location of the parking space in relation to the historic centre, etc.

The first four points above are related to the pilot project that will be operational by the end of 2011. Point number 5 is focused on offering guidance in regards to the political decision process and involves all stakeholders, such as professional transport operators, small businesses, etc.

Brief outline of the draft SIM project, talking into consideration all the following steps in implementing the SIM project:

- Collection of feedback from the traders involved related to:
  - Functionality
  - Identify area locations for SIM
- Description of functionality
- Compile tender competition descriptions
- Implementation of equipment
- Technical adjustments

A simple logistical management system for limited-access zones for goods vehicles in medium-sized cities

Authors: F. Ballini, R. Bozzo, R. Genova, S. Migliaccio, G. Rinaldi

2. A Case Study of La Spezia

In 2006, the City of Spezia([1]) prepared an updating of its Urban Traffic Plan (*Piano Urbano del Traffico*, or PUT)([2]) based on the general directions of town planning included in the City's Strategic Plan.
One of the objectives of the update is to improve accessibility to and liveability in the city centre, with a priority for working on the regulation of traffic and parking. The City decided, therefore, to adopt technological solutions to support the application of government transportation policies, and as a result, has an experiment for controlling access zones already underway in the framework of a project financed by the Region of Liguria. Regarding aspects of "city logistics", the City, using results from a study performed by the same CIRT (Interuniversity Centre of Transport Research) which analysed the nature of goods distribution in an area of interest, intends to introduce a government policy whose implementation requires equipping the city with a system called SIM (Goods Exchange System).

Figure 1. The City of La Spezia

The general objective of the project is to test a system of data transmission and computer services to aide urban goods delivery logistics, based on ICT (Information and Communication Technology) solutions easily used by (either autonomous or affiliated) goods transport operators, that allow for overcoming several problems originating partly from the industry's excessive fragmentation. SIM's fundamental goal will be that of improving accessibility to pedestrian zones and/or limited-access zones for urban goods distribution operators, in order to reduce the direct costs of transport, including transit time and timewasters related to the search for parking and the completion of

([1]) La Spezia is the capital city of its namesake province in the region of Liguria. With its 95,3721 inhabitants, it is the second most populated city of the region, (its suburbs number 136,000 inhabitants), preceded only by the regional capital Genoa.

([2]) For cities in Italy, the PUT is a compulsory tool for transportation planning in urban areas.

loading and unloading, as well as the overall costs of transport, definable in terms of impact on the environment and on the community.
A fundamental characteristic of the system will be its flexibility with respect to potential users, who will be able to easily, quickly, and effortlessly equip themselves with identification devices on board their vehicle (OBU – On Board Unit). The interaction of this equipment with specific concentrators along the roads, in turn connected in a control centre, will create the global architecture of the system.
The flexibility of the application, set as a basic requirement, allows for the identification devices placed along the road to be removed and transported with relative ease (for example, to set the parking area in an adjacent site on the basis of changing needs; or from a timing perspective as well, the system will be able to define (and even modify) times of allowed access (either by the day or the hour)).
In this way, the public authority of the City of Spezia anticipates regulating authorised vehicles' access to areas of greater environmental worth and with strong commercial value, adjoining and, in part, including the historic centre of the City, rationalising transits and stops with positive effects on environmental quality (emissions, noise, and congestion).

3. Surveying the operators

In order to define the situation of goods mobility in the survey area, a preliminary operation for determining SIM's requirements, specific surveys were carried out in the City of Spezia. On the one hand, they were aimed at completing an analysis of the mobility generated by commercial businesses, and on the other, they were aimed at identifying features of the current options for goods transport in the survey area, comprising both carriers who perform periodical restocking for businesses and carriers who occasionally deliver or collect goods from those businesses.
To this end, a questionnaire was prepared, favouring obligatory multiple-choice questions, so as to facilitate both the interviewee in specifying a response and the subsequent acquisition and analysis of the results. Implementation of the interviews was carried out with the active collaboration of the trade association (ConfCommercio).
The contents of the questionnaires essentially concerned the following aspects:

- personal details of the carrier (for the purpose of determining their location in the area);
- size of the point of sale and possible warehouse;
- goods delivery methods (third parties, self-transport, etc.);
- areas used for loading/unloading;
- weekly/monthly frequency and daily schedules of goods deliveries and/or collection;
- characteristics of the delivered or collected packages;
- opinions with regards to possible initiatives promoted by the City for improving the system of urban goods distribution.

The following section relates a summary of the results, grouped into individual items of interest for the SIM project.

3.1 Survey Area

In the survey area, represented below, a total of 1,047 fixed-address business licences are currently issued, of which 415 (about 40%) are located in an area already destined for pedestrians.

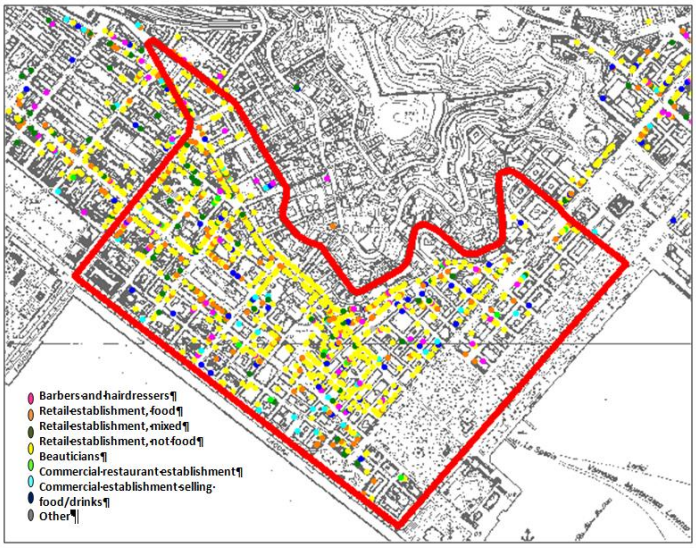

Figure 3. Distribution of commercial businesses by type in the survey area

The majority of the commercial businesses located in the area (70.8%) have a stockroom within the point of sale, whose area is attested at an average of 43.4 m^2, equal to a little more than a third of the sales area (always using the average value) of the same businesses (112.8 m^2). The available stockroom area is seen as sufficient by two out of three operators.
With regards to transport and parking methods, results from the questionnaires indicate that a little over half of the goods (57.8%) are transported via express and/or traditional carriers, while the remainder is divided between self-transport (25.0%) and third party carriers (17.2%). The areas used for parking during loading and unloading are predominantly unauthorised public areas (62.1%); this factor contributes to diminishing the actual traffic capacity of the streets. The greatest obstacle for loading and unloading operations is attributable to the lack of areas dedicated to parking for goods vehicles (68.8% of responses), while to a lesser degree, interviewees indicated an insufficiency of hours of access to limited-access zones (15.6%) and the coinciding of deliveries with the businesses' opening to the public (12.5%).

Authors: F. Ballini, R. Bozzo, R. Genova, S. Migliaccio, G. Rinaldi

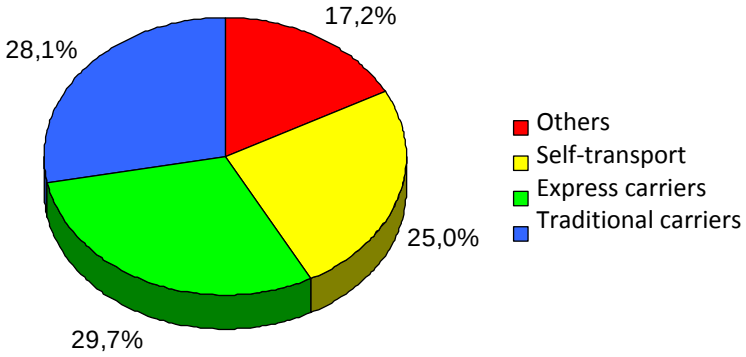

Figure 4 – Customary method of goods transport

In 67.7% of the cases, business owners stated receiving goods from their suppliers with a frequency of more than once a week (typically three or four times), and in 19.4% of the cases, on a daily basis (excluding holidays).
With regards to distribution schedules, few deliveries are made during the calmer traffic periods (only 6.9% before 7 AM and 4.2% after 8 PM). Whereas the distribution of deliveries during the rest of the day is rather even, except for the hours between 9 AM and 12 PM, which were indicated by 26.4% of interviewees.
Nevertheless, city traffic conditions and the scarcity of parking reserved for goods delivery do not seriously affect the punctuality of deliveries: 54.2% of interviewees stated that less than 10% of deliveries arrive late. Deliveries primarily consist of between 6 and 10 packages (50.0%), for a total weight varying between 15 and 30 kg (55.6%).
Deliveries are largely carried out by professional carriers (83.3% of responses), using medium-to-large capacity vehicles (72.0% delivery vans and 16.0% lorries). In 57.6% of the cases, delivery expenses are charged to the supplier. Seventy-five percent of interviewees stated that they also perform deliveries on their own which very often occur more than once a week (66.7%), without being consolidated into one specific day. With regards to timing, almost half of the deliveries are concluded by 12 AM (48.8%), and at any rate, they aren't generally made after 8 PM.
Movements are largely directed toward the outside of town (65.2%), and only 8.7% take place within the city centre. Self-transport deliveries are less "professional" and almost exclusively use cars (52.2%) or vans (39.1%) as the vehicle.
Fewer commercial operators, meanwhile, carry out home deliveries for their clients (33.3%); these take place predominantly via self-transport methods (71.4%), using cars or vans (77.7%). Home deliveries, therefore, also make use of a less "professional" transport.
Home deliveries happen at least once a week in almost two out of three cases (62.5%) rather uniformly throughout the day (including the hours before 7 AM and after 8 PM), though they are slightly more concentrated between 9 AM and 12 AM, and between 5 PM and 8 PM.
The most common destination for home deliveries is the city centre (43.8%), but one out of four deliveries go outside the city limits.

3.2 Initiatives for improving urban goods distribution

What emerges from the data presented in the previous paragraph is that the industry of goods distribution in the precincts of the area of interest holds a major role in significantly contributing to urban traffic congestion. The absence of proper planning for trips that take place casually or regularly leaves ample space open for its realisation as much within the area being discussed as in city traffic overall. At the same time, operators will be aided in finding the best road conditions and being provided with the certainty of having a place to park, via the SIM system.
All this, even if a lack of trust in initiatives for improving urban goods distribution emerged from the questionnaire from the great majority of interviewees:

- 91.7% do not deem computerised management of the procedures of goods acquisition/delivery useful;
- 87.5% are not willing to delegate certain computerised operations related to the logistics chain to a prospective centralised goods distribution centre;
- 91.7% are not willing to pay an annual subscription fee to make use of a centralised delivery system in place of the current distribution system based on small carriers and self-transport

4. Information systems and related support features of the SIM system

4.1 Functional requirements of the SIM project

Areas reserved as parking for goods vehicles and the related parking spaces arranged in the implementation area (Figure 1) will be operated through a computerised reservation system (via internet and mobile phone) that, upon registration, will allow professional carriers, craftsmen, merchants, and all entitled parties to reserve a space and therefore be guaranteed of finding that space available.

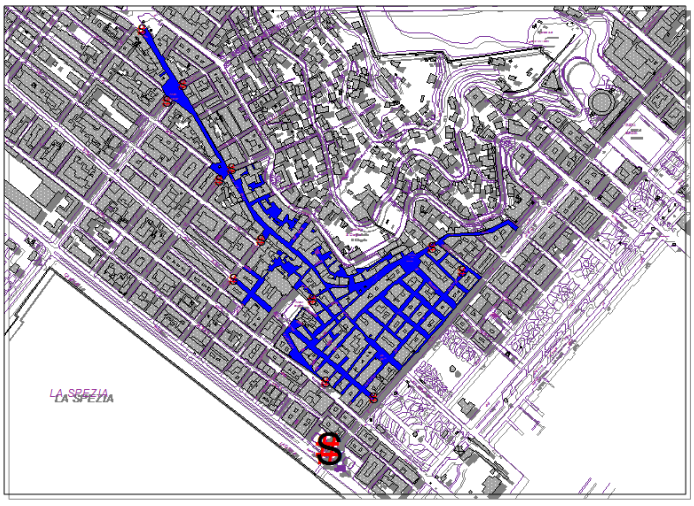

Figure 2. Survey area and target area for SIM implementation

Every entry into the defined area, both those resulting from the movement of goods (the most frequent cause), and those resulting from other reasons (taxis, invalids, police, emergency services, etc.) will be regulated by the SIM system. Through suitable technical solutions or strategic choices, the system must take into due consideration the possibility of urgent, unexpected entries by emergency vehicles not equipped with an OBU.
For this reason, a "no barrier" solution has been chosen, thanks to the presence of devices monitoring illegal occupation of the parking spaces, together with the creation of routes that render the area under discussion unsuitable for being crossed or cut through (creating closed courses, where possible).

The SIM system's functioning is schematically described as such:

1. through the computerised system, entitled operators register to the SIM system and receive a personal parking permit;
2. using vehicle sensors, the system can recognize when a space is occupied and, therefore, to calculate the duration of parking in each space;
3. by means of the information system, via PC or mobile phone (therefore even by a simple SMS), the operator can find out whether or not spaces are occupied in advance;
4. upon parking, the operator is recognised by the system, by means of his permit and thanks to an equipped post (totem);
5. the operator keys into the post, identifying the space as being occupied;
6. parking is metered: the price will be determined in the course of implementing the system with the aim of ensuring that parking spaces are only used when truly needed;
7. non-payment, or in other words, illegal occupation of the space, will result in sanctioning by traffic officers;
8. payment may be made by means of the SIM registration permit (prepaid, or pay-as-you-go). Using the vehicle sensors, the system can calculate the duration of parking and debit the price directly from a bank account;
9. an annual subscription fee for the SIM service is expected, of a very low cost though, (especially for the first year) to stimulate use of the system.

4.2 Issuing the Permits

The central server system implemented with the SIM project will interface directly with the registry's and business activities' information systems (such as the Chamber of Commerce) to verify in real time if an applicant is entitled to enrol.
In other words, the system can perform immediate, automatic tests to verify whether applicants possess the requirements for receiving a permit (owner, vendor, or craftsman with a business in the specified zone, carrier, etc.). If the cross-check results favourably, the permit will be granted and delivered to the citizen/operator. The central server will implement permit-issuing rules as

defined by the public authority responsible for determining in detail the areas affected by the restrictions and the methods of authorisation. It therefore follows that on the basis of a specific street number and an applicant's individual characteristics, a specific permit can be issued according to predetermined categories.
This open system will be capable of communicating with other applications using standards recognised in the field of distribution applications (web services), with an eye toward integrating SIM with other instruments of regulation and mobility information.
In this sense, interaction with other administrative databases (such as the *Pubblico Registro Automobilistico*, or Automobile Registration Board) could be arranged, with possible video cameras set up to monitor entryways, traffic control officers equipped with handheld devices, and parking meters used for payment, via special concentrators. Moreover, installed parking meters (that is, not only those tied to the SIM project) could also handle permit renewals, thereby avoiding the need for users to return to the project's offices.

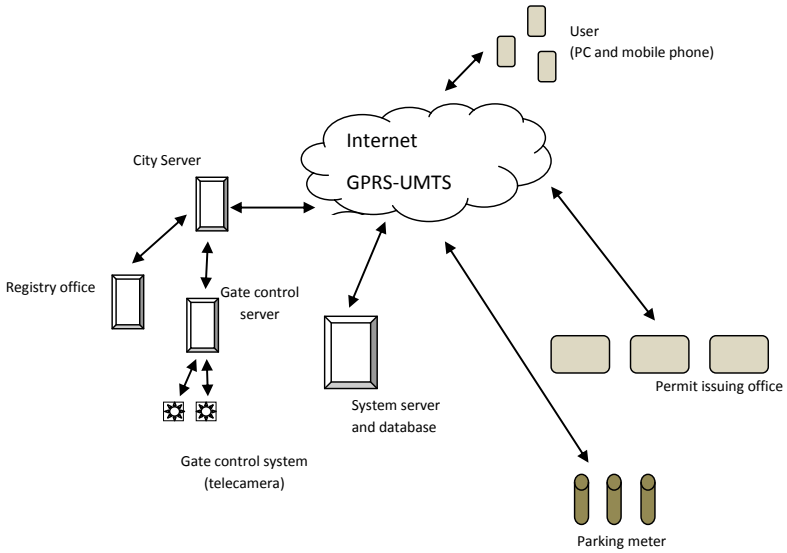

Figure 3. Sistema Città, a database at the service of the user

5. Summary and conclusions

In conclusion, it can be affirmed that urban goods distribution in the city of Spezia is characterised by a heightened fragmentation of commercial businesses, as evidenced by their floor spaces' medium-to-small dimensions, in both retail sales and in restaurant activities, which becomes even more pronounced when the survey field restricts itself to pedestrian zones.
The greatest obstacle for deliveries and consignments is created by the scarcity of parking areas reserved for goods delivery, which translates into a heightened incidence of illegal parking. Even though these parking problems are greatly felt, it is found that deliveries are made with a fair level of efficiency and punctuality, a sign that the current distribution system is sufficiently structured.

A simple logistical management system for limited-access zones for goods vehicles in medium-sized cities

Authors: F. Ballini, R. Bozzo, R. Genova, S. Migliaccio, G. Rinaldi

Merchants are not very favourably inclined toward the introduction of computer systems interposed between them and the carriers, or toward the presence of a centralised goods distribution service. It therefore follows that these emerging problems can be resolved by means of an appropriate management policy for the territory, supporting a more efficient, detailed control of the actual availability of parking (or time slots) intended for each different element of the traffic flow. In this regard, the SIM system offers the Local Authority a valuable tool for streamlining the use of available resources and street access regulation, as well as the allocation of loading/unloading areas. As a result of the introduction of regulation policies and their related systems, it is expected that a desired reduction in polluting emissions can be achieved, relative to several factors:

- potential expansion of pedestrian zones and limited-access zones, made possible by technologies and policies proposed in the project, with an 80% reduction in the flow of vehicles circulating in the area of interest;
- regulation and optimisation of entrances, traffic, and parking in order to reduce periods of exhaust emission and therefore reduce pollutants.

An estimate performed determined that it would be possible to observe reductions in chemical pollutant emissions (up to 5% for PM-10, and up to 20% for other sizes) and in acoustic pollution of up to 100% for readings at a level within the limits of the law.
If these reductions occur in the area of interest that will enjoy the greatest benefits (a general decrease in traffic and the introduction of time periods closed to traffic), the city's mobility overall could also experience an appreciable improvement. Streamlining the flow of goods vehicles, to be concentrated if possible during non-peak hours, and their distribution throughout the day, will promote a decrease in traffic congestion. The improved liveability of the city centre (both in residential and commercial areas) in which unauthorised vehicles will be barred entry will favour access for methods of transport in line with environmental protection policies (public transportation, and car and bike sharing).

The study has been helpful in understanding the traffic flow of goods within urban La Spezia. A phased approach was adopted to involve stakeholders and to carefully monitor the consequences of each individual access restrictions for goods vehicles. The process involved:

- The establishment of monitoring groups of stakeholders, such as trade and transport organizations with the aim of developing a shared management policy of the lots used for the loading and unloading of goods
- Identifying the pilot project areas and encouraging users to subscribe to the SIM system.
- Controlling the allocation of lots and the identification of vehicles using ITS (Intelligent Transport System).

The test phase for the SIM project will end in 2011, allowing the project to be implemented in 2012 as part of the city's improved overall traffic policy that will include a number of ZTLs (limited traffic zones).

References

[1] *Integrated Programme for Mobility and Efforts of Immediate Intervention, (October 2003).La Spezia, Italy.*

[2] Delivery of Goods, (2003). 21st Century Challenge Urban Goods Transport, OECD.

[3] *CityTech Project (2006). Feasibility study of ICT application in the field of logistics and goods transport, Traffic Research Centre, La Spezia Office of Mobility, Italy.*

[4] *"Report on goods mobility in the urban area of Spezia", (October 2006).Study edited by the Interuniversity Centre of Transport Research, University of Genoa, Genova, Italy.*

[5] *Maggi E.,(2007). Urban goods logistics, Economic and Regulatory Aspects*, Polytechnic of Milan, Polipress Editore, Italy.

[6] Felix Bierbrauer, (December 2009).Incomplete contracts and excludable public goods, Preprints of the Max Planck Institute for Research on Collective Goods Bonn 2010.

[7] Website, http://www.comune.laspezia.it/Accessibilita/accessibilita.html

[8] F. A. Pugliese, G. Montesano & G. Valenti, (2009). Urban Traffic analysis a large scale floating car data system, Urban Tranport XVI, Wessex Istitute of Technology, UK.